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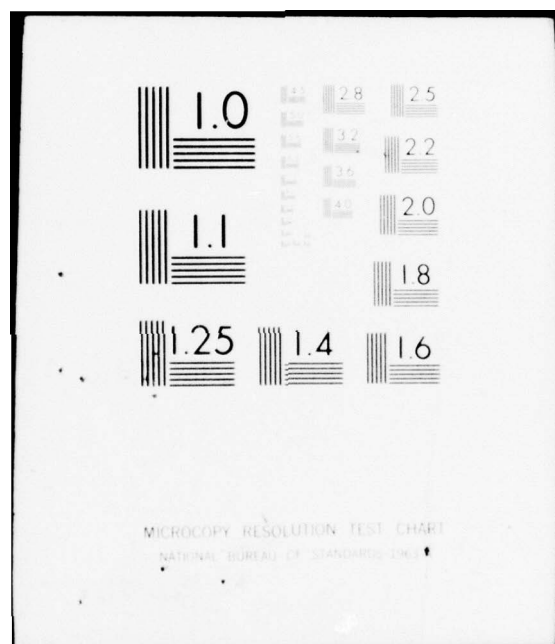
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AN APPROACH FOR MANAGING AN ENERGY CONSERVATION PROGRAM

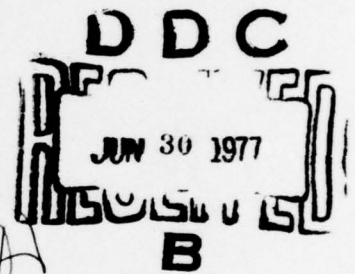
CENTER FOR BUILDING TECHNOLOGY

NATIONAL BUREAU OF STANDARDS

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APRIL 1977

FINAL REPORT FOR PERIOD DECEMBER 1975 TO JANUARY 1977



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AIR FORCE CIVIL ENGINEERING CENTER

(AIR FORCE SYSTEMS COMMAND)

TYNDALL AIR FORCE BASE

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PREFACE

This report is the management portion of a two-report Energy Conservation effort prepared by the Staff of the Center for Building Technology of the National Bureau of Standards (NBS) for the Air Force Civil Engineering Center (AFCEC), Tyndall AFB, Florida.

This report is designed for use by managers to enhance their understanding of energy conservation measures and to assist them in developing a comprehensive energy conservation program. The second report, AFCEC-TR-77-12, provides the necessary engineering information for Staff engineers to evaluate and implement appropriate energy conservation measures.

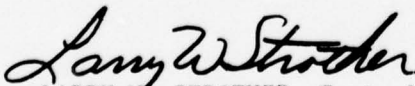
This report, the results of research performed during the period December 1975 to January 1977, was submitted by NBS to AFCEC on 22 January 1977. The basic document for this report was prepared by NBS. The document was reviewed and revised by the Director of Facilities and Systems, Energy Division, of the Air Force Civil Engineering Center. The NBS program manager was Clinton W. Philips and the NBS project leader and coordinator was Douglas M. Burch. The AFCEC project officer was Captain Larry W. Strother.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nations.

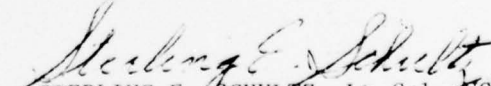
On 8 April 1977, AFCEC was reorganized into two organizations. AFCEC became part of Air Force Engineering and Services Agency (AFESA). The R & D function remains under Air Force Systems Command as Det 1 (Civil and Environmental Engineering Development Office (CEEDO)) HQ ADTC. Both units remain at Tyndall AFB, Florida.

The energy program, of which this effort is a part, is now the responsibility of CEEDO/CNF and continues with the same overall objectives and personnel.

This report has been reviewed and is approved for publication.



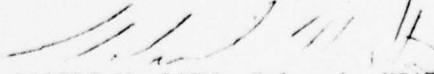
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INTRODUCTION

As the national energy shortage becomes more critical, the Air Force must make every effort to conserve energy. In this regard, the Air Force, in cooperation with the National Bureau of Standards is publishing two technical reports on Energy Conservation in existing buildings. These technical reports provide guidelines for use by management and technical personnel at the base level.

The purpose of AFCEC-TR-77-11 is to assist base level managers in conducting an energy conservation program. Guidance is provided on establishing a management structure to implement the program, analyzing options for energy conservation in various facilities, establishing both short- and long-range plans for energy management, gaining the support of all base personnel, monitoring program progress, and providing continuing energy conservation education.

AFCEC-TR-77-12 provides details primarily on technical aspects of energy conservation; that is, the specific modifications which can be made to systems and their components so energy efficiency is maximized.

The Air Force has recognized the need and potential for energy conservation through a planned program for the management and conservation of utilities. This program was formalized with publication of AFM 91-12 in August 1971, two years prior to the oil embargo. Because of its efforts in the field of energy conservation, in 1976 the Air Force was able to meet its continuing goal of zero energy growth (based on 1975 consumption base). However, simply meeting this goal is not enough. Even with zero consumption growth, the cost of the energy consumed continues to increase. The only way to alleviate this dilemma is to reduce energy consumption.

Energy management is a concept which can be used to address this challenge. Energy savings are achieved not only when a system is used less, but also when the system is as efficient as possible. In other words, a system which wastes energy, wastes it every time it is used, regardless of how much or how little. Thus, by exploring the systems involved, the number of possible ways in which energy-conserving options can be applied is expanded greatly.

Energy management pays for itself. Many of the most effective options can be implemented with an expense of nothing more than a few hours of effort, others may take just minimal investment, and still others may require an extensive amount of capital funding. However, numerous studies have shown that even large capital expenditures may pay for themselves in justifiable time frames. In other words, do not limit your thinking, but consider all options.

It must be recognized that technical matters are not the only ones involved. Numerous human concerns must also be addressed. A substantial effort must be made to involve all base personnel to ensure that they are committed to the concept of energy management and are motivated to lend their support and cooperation.

While no one should expect overnight miracles, the information presented in this report should help to attain substantial reductions in base energy consumption without any reduction in the standards of comfort, safety, security, and productivity, and without having any impact whatsoever on the most important goal of all--achieving the mission.

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CHAPTER 1

BACKGROUND

The United States has always been a land of abundant energy resources, thus enabling the nation to support a continual expansion of commerce and industry. This expansion, in turn, has been responsible for providing American citizens with the highest standard of living in the world.

As shown in Figure 1-1, the nation has come to rely most heavily upon petroleum as an energy resource. In the early 1950s, however, the nation's demand for petroleum began to outpace its supply. As a result, the United States began to import crude oil. By 1970, foreign oil accounted for 23 percent of domestic consumption. This situation had far-reaching complications. In 1973 when the Organization of Petroleum Exporting Countries (OPEC) nations imposed an embargo on crude oil shipments to the US, it became apparent just how dependent the US was on foreign sources for crude oil. Yet, to date the situation has not improved. Presently, the US is importing approximately 50 percent of our crude oil requirements. Energy dependence has increased.

Energy conservation is the fastest and most effective way of moving away from energy dependence. Although conservation itself will not solve the problem of depleted fossil fuel resources, it will buy time for the development of alternate and new energy resources. These are two primary methods of achieving energy conservation.

The first method utilizes end-use restrictions, that is, demanding less of the systems that consume energy. Lowering thermostat settings in winter and reducing lighting requirements are examples of two common end-use restrictions. While these and similar techniques reduce energy consumption, they also may degrade human comfort and productivity, and, in some cases, safety and security as well. As such, their drawbacks can sometimes outweigh their benefits.

The second method concentrates on the efficiency of the systems which provide end-use services, with an eye toward making these systems as efficient as possible. The idea is that an inefficient system wastes energy every time it is used, no matter how much or how little, but an efficient system consumes the minimum amount of energy needed to get the job done at all times.

Shortly after imposition of the 1973 oil embargo, the President encouraged all Americans to conserve energy through voluntary adherence to end-use restrictions. While this conservation technique can be effective in the short-term, its long-term effectiveness is limited, primarily because the number of possible end-use restrictions is limited.

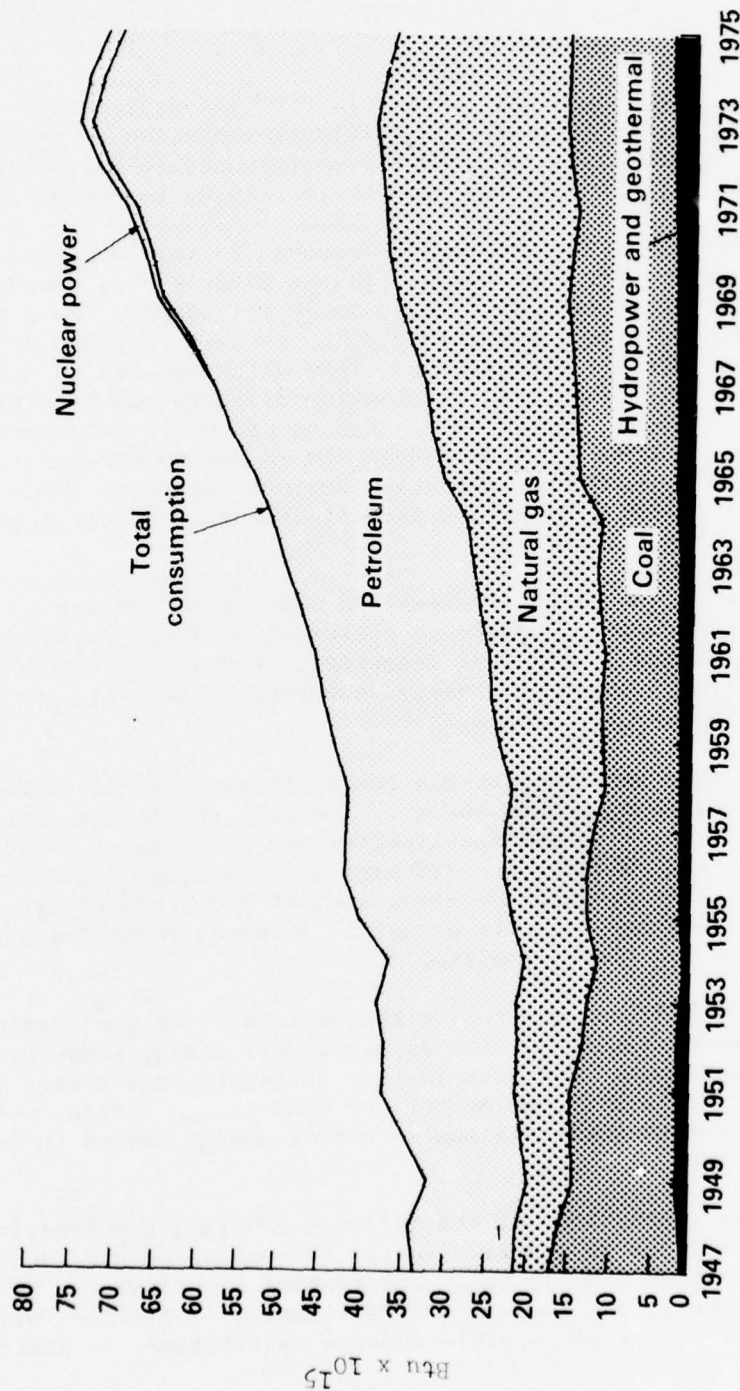


Figure 1-1. Total U. S. Energy Consumption

Source: Energy Perspectives 2 (second edition), Bureau of Mines, U.S. Dept. of Interior, June 1976.

The increased oil imports also indicate that a program of this type is not the total answer.

The energy conservation method being advanced in this report is a combination of both methods, with emphasis on maximizing efficiency.

Efficiency maximization has two primary benefits. First, it will identify many more ways to conserve. Prior to the embargo, when energy was cheap, there was no perceived need to make systems more efficient, nor could energy efficiency be justified economically. As a result of this cheap energy, many existing systems are inherently wasteful. However, because these systems are comprised of so many components, and because many of these components can be modified to improve their efficiency, existing systems provide great potential for savings. In most cases, these savings can be realized through modifications which do not affect comfort, safety, security, productivity, or the ability of the Air Force to achieve its mission.

The second benefit of efficiency maximization is flexibility. Because there are so many options available, those directing the energy conservation effort are able to establish which options will be exercised first, which second, etc., so that the overall plan meshes well with other objectives that must be pursued.

Because of the great number of energy conservation options created when efficiency maximization and end-use restrictions are combined into one program, and because the order of implementing those options must be planned, the entire energy conservation program must be managed. This management must be a team effort. Comprehensive management emphasis and techniques must be brought to bear if the full potential for energy savings is to be realized. These management requirements will be addressed in more detail in Chapter 2.

Right now the Air Force is being affected seriously by the high cost of energy. As shown in Table 1-1, the Air Force has been able to meet its current goal of zero energy consumption growth (based on 1975 consumption), but the skyrocketing cost of energy has resulted in still greater expense. As shown, consumption in 1976 is 18.6 percent less than it was in 1973, but the cost for energy is almost 118 percent more.

TABLE 1-1. AIR FORCE ENERGY CONSUMPTION

<u>Fiscal Year</u>	<u>Total AF Energy Consumption</u>	<u>Energy Costs</u>
	10 ⁶ MBTU	10 ⁶ Dollars
1973	242	163
1974	209	185
1975	204	311
1976	197	355
1977 (Estimate)	197	386

While we can never hope to return to the prices that prevailed before 1973, the Air Force can achieve the goal of zero energy growth and, with diligence and effort, even surpass that goal. In attempting to do so, however, it must be recognized that the primary goal of the Air Force is achievement of its mission. Maximizing energy conservation while maintaining full mission capability in the face of ever increasing energy costs is one of the most significant peacetime management challenges the Air Force has ever faced. Through application of energy management, and with your help, both goals can be achieved.

CHAPTER 2

INITIATING AN ENERGY MANAGEMENT PROGRAM

Initiating an energy management program requires a team effort wherein members of the team understand the objectives of the program and are committed to achieving them.

As indicated in the previous discussion, energy management requires application of both technical and managerial skills. The purpose of this report is to outline management considerations. Technical requirements are detailed in AFCEC-TR-77-12.

2.1 Program Challenges

To be an energy manager today is a tough job. If you have a "too hard" or "can't do" file, you may stop reading here. If you are ready to get in the energy swamp and tame a few alligators, get rid of a few, and generally, get all the other residents of various origin and interest fully supporting energy conservation, then press on! This document will be of considerable help to you.

There are many problems that must be addressed. First, money for capital expenditures to modify buildings and their systems are limited. Energy conservation projects that pay back in future years require today's dollars, and must compete with dollars required to support the mission. It is difficult to look down the road, but certainly an appropriate amount of dollars spent on energy conservation today will favorably impact our ability to support the future mission. Next, you have the average building occupant who is very energy conscious; however, is generally unwilling to put up with any degree of restriction within his work area or living quarters. In addition, there are still those residents of the swamp who do not actually believe there is an energy crisis and are diametrically opposed to anyone saying energy must be saved at all. And then there is "guidance" which is relatively easy to obtain. Today there are many sources of guidance on energy management and conservation. We consider this report to be a compilation of the best guidance, but it is just a place to start. The real challenge at all levels is actually getting the energy management jobs done.

2.2 Program Objectives

The objectives of an energy management program are to ensure that:

- a. Fuels and electricity are used without avoidable waste,
- b. All energy-consuming systems such as heating, ventilating, cooling, hot water, internal transportation, power, and other processes are operated and maintained efficiently and economically, and

c. Personnel are made aware of the importance of energy conservation and the need for limiting the use of fuels and electricity to actual requirements.

2.3 Management Commitment

What must be done to establish an effective energy management program? There are five critical steps which management must accomplish to ensure that an energy management program is initiated and operates in an effective manner. These steps are:

- a. Establish a clear commitment of subordinate managers to energy management.
- b. Establish an energy management team with a single point of contact who is a decision maker, understands energy management concepts, and has the direct support of top management.
- c. Staff the energy management team with personnel experienced in heating, ventilating, and air conditioning system design and control, physical plant operation, maintenance, and facilities programming as a minimum and provide them the necessary time to do the job.
- d. Direct each base unit to appoint a representative to interact with the energy management team.
- e. Publicize the top management commitment and the results of the energy management team's efforts.

2.4 Program Framework

AFM 91-12, Policies, Procedures and Criteria for the Management and Conservation of Utilities, provides the necessary framework to establish this energy management program. Before proceeding further with this document, Chapters 1 through 3 of AFM 91-12 should be carefully reviewed. Some form of a utilities management and conservation program is in effect at all bases. Certainly, the entire program can be enhanced with this strong emphasis on energy management.

2.5 Procedures

Procedures to be followed for implementing a successful Energy Management Program with the ultimate goal of conserving energy and containing costs are discussed below. More specific detail regarding each element of these procedures is provided in subsequent chapters.

2.5.1 Collecting Energy Use and Cost Data

Using utility and other records, collect data on various forms of energy used. Establish, where possible, the historical energy consumption profile of buildings and systems to identify how much energy typically is

consumed and primary causes of variances. The energy use profile will help in identifying energy conservation options which can be employed. This data also establishes the benchmark from which energy reduction goals can be set for the team to work toward. Simply stated, unless you do this, you won't know when your energy conservation job is done for each building.

Cost data collected will provide the basis for calculating cost savings in later steps and prioritizing projects for programming, design, and accomplishment.

2.5.2 Identifying Energy Conservation Opportunities

A comprehensive survey of facilities by appropriate team members is the best way to identify facilities and systems that are large energy users. It also determines where inefficiencies exist because of the operation and maintenance practices being followed, or because of poor equipment condition, etc. Simply stated, unless you know where the energy is being used within a building, you can not attack the areas that are energy intensive.

Metering offers an excellent means of determining building energy consumption. It may also be the most economical way. Without metering, extensive engineering manhours are required to obtain similar information, which is at best an educated guess. It should be noted that provisions for both permanent and temporary metering are contained in AFM 91-12, Chapter 5.5.

Although all facilities must be surveyed, those which deserve special attention include:

- . buildings which are comparatively large energy consumers due to factors such as their size, special processes and equipment, etc.
- . buildings which have overheating and overcooling problems.
- . buildings with structural defects, and
- . buildings used for purposes other than those for which they were designed.

Comprehensive information regarding the survey is provided in Chapter 3 of this report and also in AFCEC-TR-77-12.

2.5.3 Analyzing Options and Establishing Priorities

After energy conservation opportunities for various facilities have been identified, analyses should be performed to determine priorities of action. Factors to be considered in establishing priorities include:

- . energy savings potential
- . cost of implementation
- . derived benefits in terms of operation and maintenance
- . ease of modification
- . manpower and timing requirements
- . effect on other systems

Simple payback will provide one means of prioritizing projects. It is also strongly suggested that the Btu's of energy saved for each dollar invested be calculated for each project and used for final prioritization.

2.5.4 Establishing the Plan

Once all options have been analyzed and prioritized, it is then possible to develop a tentative timetable indicating which options will be exercised, the year in which they will be exercised, and how much they will cost, etc.

The plan must contain more than this timetable alone. It must also indicate such things as who will be responsible for compilation of data; how the various individuals will perform their tasks; the types of communications and promotional programs that will be developed to gain the cooperation of all base and tenant personnel, and so on.

Once the energy management team has addressed all these factors and concerns, the plan is ready for presentation to the Base Utilities Management and Conservation Committee. Each member of this committee should be given ample time to review the basic plan with subordinates or superiors. Because the success of the plan rests so heavily on obtaining cooperation, it is essential that any reservations expressed by committee members be given careful consideration.

Following committee approval, those portions of the plan requiring action by the Base Real Property Resources Review Board (RPRRB) can be forwarded for review and approval. It will then be possible to establish an overall goal for the Base Energy Management Program. In essence, the goal is the sum of the energy savings which will be achieved by implementing all first-year options. In computing the goal, however, recognize that the energy to be saved in the first year depends on when these options will be implemented and the time remaining in the year.

2.5.5 Establishing an Energy Conservation Goal

Although the Air Force has set certain conservation goals in different areas, the plan should indicate the possibilities for conserving

further without degrading the mission. Set conservation goals for every phase of the operation in terms of Btu's to be saved per year. Exactly how large these goals should be or how they are expressed can differ according to the situation. Whatever the goals, they should be tough, specific, measurable and feasible.

2.5.6 Implementing Conservation Actions

With the plan and goals established, the process of implementing the options identified in the plan, the management tasks required to monitor these actions and report on their success, as well as gain basewide commitment, cooperation, and support, can begin.

2.5.7 Continuing Energy Conservation Actions

The results of the program should be evaluated continually and be reported to all levels. Solicitation of ideas from all personnel is a necessary part of the program. Everyone must be involved and motivated to produce the desired goals.

CHAPTER 3

IDENTIFYING THE POTENTIAL FOR ENERGY CONSERVATION

To identify the potential for energy conservation on a base, it first is necessary to conduct a comprehensive survey of all buildings and central plant systems (You have to get in the swamp!). Once the survey is performed, it is analyzed to identify how and where modifications can be made to achieve energy conservation in a cost-effective manner.

3.1 Conducting the Building Survey

The building survey is one of the most critical elements of a Base Energy Management Program because survey findings form the foundation for the energy management plan.

The primary purpose of the survey is to identify where and why energy is consumed in and by base buildings and central plant systems. The idea behind this approach is that, to achieve energy conservation, one first must understand how energy is consumed.

For the survey to be meaningful, it is essential that all personnel involved recognize that base buildings and central plant systems as a whole can be segregated into three separate systems which, due to their interrelationships, cause energy to be consumed.

- . Energized systems, meaning those systems which consume energy directly. These include systems and components used to provide heating, ventilation, cooling, lighting, etc., as well as pieces of equipment such as typewriters, television sets, etc.
- . Nonenergized systems, meaning those systems which do not consume energy, but which do impact upon the amount of energy energized systems must consume to serve a given function. Typical non-energized systems include windows, walls, roof, floors, etc.
- . Human systems, meaning those persons who somehow affect the amount of energy consumed. Human systems include virtually all base and tenant personnel, and especially those responsible for operations and maintenance.

In every case, the interrelationships of these three systems or groups of systems over a specific period of time determines the specific amount of energy which will be consumed in that period. Accordingly, a modification to any one of these three systems will modify the amount of energy consumed. For example, if the Base Civil Engineer (human systems) instructs base facilities maintenance personnel (human systems) to paint dark interior walls (nonenergized systems), a light color to improve light reflectance characteristics in a room (nonenergized systems), it may enable reduction in the number of lamps or luminaires (energized systems) to

retain the required illumination levels for comfort and productivity (human systems). Reducing the number of lamps and/or luminaires, when performed correctly, will reduce not only lighting energy consumption and costs, but also interior heat gain. During summer months, this means cooling systems (energized systems) may have to consume less energy to maintain desired conditions.

Proper conduct of the survey is essential to development of an overall Energy Management Program. It is essential that individuals as described in Chapter 2, para 2.3c, perform this survey. It is also essential that appropriate time is allowed to perform this work. The results of this survey will be the basis of the whole program. An accurate and thorough survey will lead to an excellent program.

If sufficient manpower and expertise are not available from base resources, consider utilization of outside consultants, such as consulting engineers, to conduct all or critical portions of the survey. Because a qualified consultant generally can bring to bear years of successful experience and a comprehensive information base, he generally can perform an in-depth survey and analysis as one task, and prepare a comprehensive report on which a substantial portion of the Base Energy Management Plan can be based.

Each Building Monitor/Custodian should be involved in the survey of his/her facility. This individual could be responsible for gathering some of the data required for the survey, such as data on energy consumption (where buildings are separately metered), operating hours, number of personnel occupying buildings in after-hours operations, etc. Building custodians become especially valuable in monitoring the program--once it is implemented--by providing some of the information required to evaluate progress of the program, how well building personnel are following recommended practices, etc.

To conduct the survey the following general steps must be taken.

3.2 Building and Central Plant Systems Identification

The initial step is to identify all buildings to be surveyed, as well as central plant systems serving these buildings. If there is insufficient manpower to survey all buildings at the same time, or within a reasonably close period of time, priorities can be established using the guidelines presented in Chapter 2, para 2.5.2.

For each building, the Surveyor should have on hand "as-built" architectural, mechanical, and electrical drawings and specifications to familiarize himself with the building's configuration and design as well as electrical and mechanical systems and equipment layout, operation and control. If "as built" documents are not available, copies of original drawings can be modified as necessary to indicate existing as-built conditions. If original design drawings are not available, it may be necessary to develop single-line diagrams to indicate mechanical and electrical systems installed. In addition, for each building, the surveyor should obtain:

- . equipment manuals
- . operating and maintenance logs
- . energy consumption data
- . related information

The surveyor also should be familiar with utility rate schedules as well as any materials which relate to any planned building modernization programs and their applications. Much of this information can be recorded on forms such as provided in AFCEC-TR-77-12.

By reviewing this information, the surveyor can get an in-depth overview of a building and the factors which cause energy consumption prior to undertaking the next step, the walk-through survey.

3.2.1 Walk-Through Survey

The walk-through survey enables the surveyor to physically inspect and, where appropriate, measure factors which affect energy consumption. (Additional information on measurement is given in AFCEC-TR-77-12. It may be helpful for top management to observe portions of the survey. It is important that everyone involved with the program personally meet the more outstanding residents of the swamp.

The items which require investigation and analysis are discussed in the following chapter. Just a quick glance indicates that some of the most critical areas include: ventilation system operation and controls and how they can be improved; airtightness of the building and how infiltration can be reduced; heating and cooling equipment including their maintenance and controls and methods of improving their efficiency; lighting and lighting levels and how they can be modified; heat-transmission characterizations and how they can be modified; occupant procedures and how they may be contributed to excessive energy consumption, and so on.

In general, it can be stated that the surveyor could start the survey in the basement and work his way up. Assuming the equipment room is in the basement, for example, he would inspect mechanical systems and record their condition, the condition of ductwork and its insulation (or indicate that there is no insulation), etc. He would observe the performance of operating and maintenance personnel on a somewhat casual basis (more fully through review of logs). In an office space, for example, the surveyor would note such things as the nature of work being performed, hours of operation, location of light switches and the number of luminaires controlled by each, habits of personnel insofar as leaving lights on, opening windows are concerned, and so on.

In making the survey, an individual should utilize, in addition to typical measuring devices, either a pad and pencil to record information, or a tape recorder. It may also be worthwhile to utilize

an instant development camera, and/or a slide camera to make record photos.

It is worthwhile to note that conduct of the survey depends greatly on cooperation from building operating and maintenance personnel. It becomes especially important to recognize that they may regard surveyors' actions as an evaluation of their performance. In some cases, this results in less than full cooperation for fear that findings might reflect negatively on their performance. For this reason, and especially when outside sources are utilized to conduct the survey, operating and maintenance personnel must be assured that the goal of the survey is to identify ways of making systems more efficient, and not to evaluate the performance, of individuals.

Once surveys have been completed, the Energy Management Team will have a complete record of "things as they exist now." Analysis of these data will enable formulation of a plan.

3.3 Analyzing Survey Findings

The purpose of analyzing survey findings is to identify actions which can be taken to reduce energy consumption. The following guidelines are provided to assist in developing the analysis.

- a. Determine where energy inefficiencies and waste now exist. This does not imply modifications to the system, but rather those actions which should be taken to bring elements of the system up to the efficiency at which they should function. This in itself can save a considerable amount of energy in most buildings.
- b. If a given piece of equipment is operating poorly, determine why. Is it because it needs adjustment, repair or replacement, is it being maintained well, or is it being operated improperly? The cause, of course, leads directly to the cure. If poor maintenance seems to be the problem, it would mean that a revised maintenance schedule may be required, or that more instruction must be given, or that other changes may be needed. Many of the guidelines provided in AFCEC-TR-77-12 will provide direction on this subject. At all times, however, consider how any change--even bringing the system up to full operating efficiency--will affect other elements of the same system or other systems.
- c. Determine where systems can be modified in accordance with guidelines provided to achieve greater energy efficiency. In so doing, consider how the modifications should be made and what the effect will be on other systems related to it directly or indirectly.
- d. Determine the problems which are likely to occur through implementation of actions, in terms of energized systems, nonenergized systems and human systems.

Tables 3-1, 3-2, 3-3, and 3-4 indicate in outline form some of the typical energy conservation retrofit options which are applicable to various types of Air Force Buildings. These options have been grouped under the following headings: (see left margin on each form.)

- . ventilation and infiltration
- . heating
- . lighting
- . cooling
- . water heating
- . miscellaneous

The climatic zones to which each table applies are shown in Figure 3-1. Climatic variables must be accounted for because weather conditions generally determine which systems will consume most energy and, accordingly, which systems offer the greatest potential for savings. Thus, heating systems may offer significant potential for savings in facilities in Maine, but very little opportunity in Hawaii.

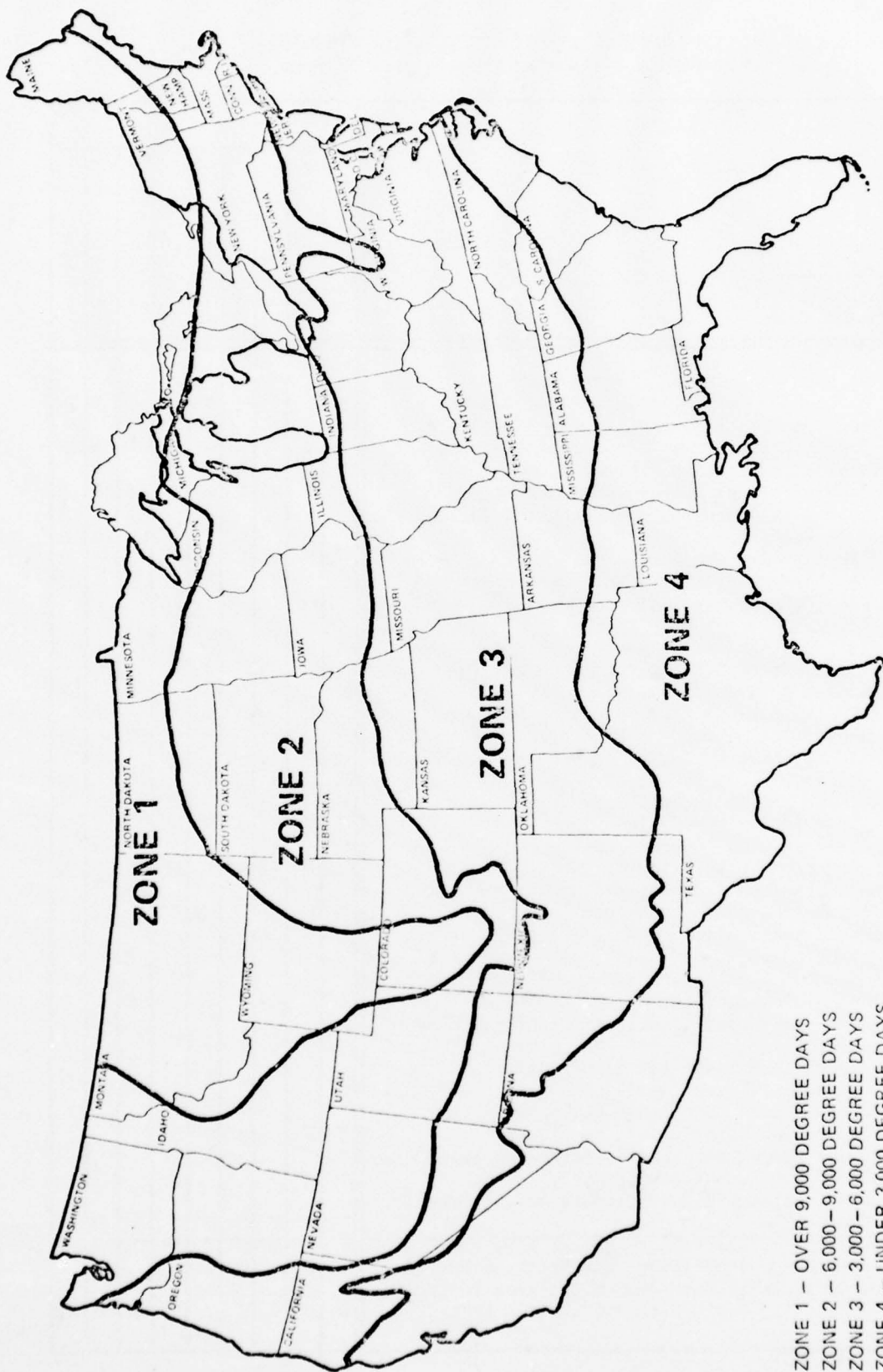
In each of the tables, the six factors identified above are listed in descending order of impact as determined by climatic factors.

The buildings for which typical modifications are applicable are listed in the upper right portion of each table. If there is a notation in the appropriate column, it means that a given option is feasible for the type building involved. The notations used (N, for no or low-cost; M, for minimal cost, and S, for significant cost,) indicate both feasibility and cost factors. Cost factors are provided primarily as very general guidelines. For each modification contemplated, the Energy Management Team should attempt to identify:

- . the precise existing condition and the reason for modification
- . the precise nature of the modification
- . the cost of modification
- . the estimated amount of energy that will be saved
- . the time required to make the modification
- . any undesirable impact which will be created during or after the modification which will tend to affect comfort, productivity, safety, security, etc.

These tables are not all inclusive and are available in various

depth in several documents. Their purpose here is to expose some of the many possible options that will form the final Energy Management Program. Find your zone and see what options might be part of your program.



ZONE 1 - OVER 9,000 DEGREE DAYS
 ZONE 2 - 6,000 - 9,000 DEGREE DAYS
 ZONE 3 - 3,000 - 6,000 DEGREE DAYS
 ZONE 4 - UNDER 3,000 DEGREE DAYS

NOTE: Alaska is in Zone 1 and
 Hawaii is in Zone 4.

Figure 3-1. U.S. climatic zones.

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac. Warehouses
VENTILATION AND INFILTRATION	Shut Down Ventilation Systems During Unoccupied Periods in Noncritical Areas	N	N		N	N	N		N
	Reduce Ventilation Rates During Unoccupied Hours to a Minimum in Noncritical Areas	N	N	N	N	N	N	N	N
	Optimize Ventilation Startup Times	N	N		N	N	N		N
	Shut-off Exhaust Systems When Not Needed	N	N	N	N	N	N	N	N
	Eliminate All Unnecessary Exhaust Hoods and Roof Ventilators							M	M
	Replace Broken Windows	M	M	M	M	M	M	M	M
	Close Fireplace Dampers When Not in Use			N					
	Repair Fireplace Damper if it Does Not Seal Properly			M					
	Adjust Outdoor Air Dampers for Tight Closure	N	N		N	N	N		N
	Reduce Infiltration Through Openings in Building Envelope	M	M	M	M	M	M	M	M
	Establish Rules for all Building Personnel Regarding Opening and Closing of Ext. Doors	N	N		N	N	N	N	N
	Install Weatherstripping Around Windows and Doors	M	M	M	M	M	M	M	M
	Caulk Around Window and Door Frames	M	M	M	M	M	M	M	M
	Install Economizer Cycle	M	M	M	M	M	M		M
	Install Loading Dock Door Seals							M	M
	Rehang Misaligned Exterior Doors	M	M	M	M	M	M	M	M
	Install Automatic Ventilation Controls to Ensure Operation as Needed	M	M		M	M	M		M
	Connect Ventilation Fans in Toilet Rooms to Light Circuit			M	M				
	Reduce the Quantity of Exhaust Air From Hoods		M				M		
	Consider Installation of Air Curtains					S		S	S
	Recover Heat from Exhaust Air to Precondition Incoming Air	S				S	S		
	Recirculate Exhaust Air Using Activated Charcoal Filters	S					S		
	Use Vestibules and/or Revolving Doors to Reduce Infiltration	S	S		S	S	S		
	Replace Hoods that are too Large and Which Move Excessive Quantities of Air		S				S		
	Install Automatic Door Closers on all Exterior Doors	M	M	M	N	N	N	M	M
HEATING	Repair all Leaks: Water, Steam, Air, Fuel, etc.	M	M	M	N	N	N	M	M
	Lower Indoor Temperature and Relative Humidity	N	N	N	N	N	N	N	N
	Add Controls to Setback Temperatures During Unoccupied Periods in Noncritical Areas	M	M	M	M	M	M	M	M

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING	N = No Cost or Low Cost M = Minimal Cost S = Significant Cost								
	Install Warm-up Cycle Controls on Air Handling Units With Outside Air Intake as applicable	M	M			M	M		M
	Use Opaque or Translucent Insulating Materials to Block Off and Thermally Seal all Unused Windows		S	S	S	S		S	S
	Install Storm Windows	S		S	S	S	S	S	S
	Add Additional Insulation to Roofs, Ceilings and Floors Over Unconditioned Areas	S	S	S	S	S	S	S	S
	Add Additional Insulation to Walls			S	S	S	S	S	S
	Consider Reglazing with Double or Triple Glazing	S	S	S	S	S	S		S
	Evaluate the Necessity for Humidification:								
	Curtail as Practical	N	N	N	N				
	Recalibrate All Controls	M	M	M	M	M	M	M	M
	Repair Faulty Equipment: Steam Traps, Valves, Dampers, etc.	M	M	M	M	M	M	M	M
	Lock Thermostats to Prevent Resetting by Unauthorized Personnel	M	M		M	M	M	M	M
	Reduce Heating in Overheated Spaces. Do Not Open the Window to Cool These Areas!	N	N		N				
	Turn Off or Eliminate all Portable Electric Heaters When Not Needed	N	N	N				N	N
	Keep Doors and Windows Closed When Heating System is Operating	N	N	N	N	N	N	N	N
	Repair Cracks and Openings in Exterior Surfaces	M	M	M	M	M	M	M	M
	Use Infra-red Television Camera System to Determine Where Heat Losses are Occurring from Buildings and Underground Distribution Piping	S	S	S	S	S	S	S	S
	Install and Maintain Insulation on all Hot Water Pipes, Fittings and Valves Passing Through Unconditioned Spaces	M	M	M	M	M	M		M
	Insulate all Steam Lines; Above Ground	S	S		S	S	S	S	S
	Insulate all Duct Work Carrying Conditioned Air Through Unconditioned Spaces	M	M	M	M	M	M	M	M
	Repair Insulation on Economizers, Condensate Receiver Tanks, Boilers, Furnaces, etc.	M	M			M	M		
	Adjust Dampers in Mixing Boxes and Multi-zone Units so that they Shut-off Tight to Reduce Leakage	N	N				N		
	Vary the Steam Pressure in Accordance with Space Heating Demands	N	N						
	Reset Heating Water Temperature in Accordance with Load	N	N						
	Operate only Heating Water Pumps Necessary	N	N						

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING									
	Reduce Hours of Fan and Pump Operation	N	N			N	N		N
	Operate Return Air Fans for Heating During Unoccupied Hours	N					N		N
	Use Lowest Possible Radiation Temperature in Perimeter Spaces	N	N	N	N	N	N		
	Add Controls to Regulate Hot Deck Temperature in Accordance with Demand	M				M	M		
	Recover Heat from Condensate	S	S		S		S		
	Recover Heat from Condenser Water System	S	S						
	Install Valves and Dampers to Permit Shut-off of Heating in Unoccupied Areas Where There is no Danger of Freezing	M	M			M	M		
	Install Automatic Temperature Control Valves in Radiators Controlled by Hand Valves	S	S		S	S	S		
	Check Vents in Hot Water and Steam Systems for Proper Performance	N	N		N	N	N	N	N
	Keep Air Movement in and out of Radiators and Convectors Unrestricted	N	N		N	N	N		
	Provide Additional Thermostats for Better Control of Heating Equipment	S	S			S	S		
	Convert Three-way Valves to Two-way Operation and Install Variable Speed Pumping	S	S						
	Balance Water Flows to Minimally Satisfactory Levels	S	S			S	S	S	S
	Clean Strainer Screens in Pumping Systems	N	N		N	N	N	N	N
	Lower the Resistance to Flow in Duct and Piping Systems	S	S						
	Trim Pump Impeller to Match Load	M	M						
	Reduce Air Flow Rates to Minimally Satisfactory Levels	S	S						
	Adjust all Pumps to Control Leakage at Pump Packing Glands	M	M						
	Maintain all Heating Equipment and Auxiliary at Peak Efficiency	M	M	M	M	M	M	M	M
	Keep Filters and Heat Transfer Surfaces Clean	N	N	N	N	N	N	N	N
	Use Low Resistance Filters, Registers and Grilles to Reduce the Horsepower Required for Air Movement	S	S			S	S		
	Reduce Fan Speed	M	M						
	Use the Minimum Number of Boilers. It is far Better to Operate One Unit at 90 Percent Capacity Than Two at 45 Percent	N	N						
	Check Flues and Chimney for Blockages or Improper Draft Conditions	N	N	N	N	N	N	N	N

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING	Clear Combustion Surfaces	N	N	N	N	N	N	N	N
	Seal all Air Leaks into Combustion Chamber	N	N	N	N	N	N	N	N
	Adjust Fuel-Air Ratio	N	N	N	N	N	N	N	N
	Maintain Proper Fuel Oil Temperature at Burner Tip	N	N	N	N	N	N	N	N
	Install Flue Gas Analyzer	S	S			S	S		
	Preheat Combustion Air With Waste Heat	S	S						
	Install Boiler Stack Economizer for Preheating Feed Water	S	S						
	Add Automatic Draft Damper Control to Reduce Heat Loss Through Breeching When the Gas or Oil Burner is Not in Operation	M	M			M	M		
	Use Proper Water Treatment to Reduce Fouling of Heat Transfer Surfaces in Boilers, Heat Exchangers, etc.	M	M	M	M	M	M	M	M
	Isolate Off-line Boilers	S	S						
	Reduce Blowdown Losses	M	M						
	Replace Existing Boilers Which are not at or near the end of their Useful Life with Modular Boilers	S	S						
	Install Central Supervisory Control System	S	S						
	Utilize Heat from Internal Spaces for Heating Perimeter Areas	S	S				S		
	Keep Maintenance and Operating Log of all Heating Equipment	M	M			M	M	M	M
	Ensure that overhead Unit Heaters Direct Heat to the Floor							N	N
LIGHTING	Reduce Illumination to Levels Consistent with Productivity, Safety, and Security Considerations	N	N	N	N	N	N	N	N
	Add Switching and Timers to Turn Off Lights When Not Needed	M	M			M	M	M	M
	Use Daylight for Illumination in Perimeter Areas as Practical	N	N	N	N	N	N	N	N
	Remove unnecessary Lamps when those Remaining Can Provide Desired Illumination	N	N	N	N	N	N	N	N
	Use Higher Efficiency Lamps	S	S	S	S	S	S	S	S
	Remove Lights Over Stacks								M
	Establish an Effective Lighting Usage Program	N	N	N	N	N	N	N	N
	Move Desks and Other Work Surfaces to a Position and Orientation that will Use Installed Luminaires to their Greatest Advantage	N	N						

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
LIGHTING	Revise Cleaning Schedule so Lights can be Turned Off Earlier	M	M			M	M		M
	Add Photocell or Time Controls to Operate Outdoor Lighting	M	M	M	M	M	M	M	M
	Keep Lamps, Luminares, and Interior Surfaces Clean	N	N	N	N	N	N	N	N
	Consider the Use of Light Colors for Walls, Floors and Ceilings to Increase Reflectance but Avoid Specular Reflections	M	M	M	M	M	M		
	Use More Efficient Ballasts	S	S			S	S	S	S
	Relocate Luminares to Provide Light on Task Areas	S	S			S	S	S	S
	Lower Height of Lighting Fixtures	S	S			S	S	S	S
	Recover Heat of Light	S	S			S	S		
	Repair All Leaks	M	M	M	M	M	M	M	M
	Reduce the Quantity of Water Used	N	N	N	N	N	N	N	N
WATER HEATING	Reduce Generating and Storage Temperature Levels to the Minimum Required	N	N	N	N	N	N	N	N
	De-Energize Booster Heaters in Kitchens at Night		N				N		
	De-Energize Hot Water Circulating Pumps when Building is Unoccupied	N	N				N		
	Insulate Hot Bare Pipes and Storage Tanks	M	M	M	M	M	M	M	M
	Replace Gas Pilots with Electric Ignition Device		M	M			M		
	Avoid Using Electric Water Heater During Periods of Peak Electrical Demand	N	N	N	N	N	N	N	N
	Insert Orifices in Hot Water Pipes to Reduce Flow	M	M	M	M	M	M	M	M
	Install Efficient Nozzles and Faucets	M	M	M	M	M	M	M	M
	Boost Hot Water Temperature Locally		S	S	S		S		
	Recover Heat from Incinerators for Domestic Hot Water Heating		S	S					
	Recover Heat from Laundry and/or Kitchen Waste for Water Heating		S				S		
	Locate Water Heater close to the Point of Use	S	S	S	S	S	S	S	S
COOLING	Repair all Leaks: Chilled Water, Condenser Water, Conditioned Air, etc.	M	M	M	M	M	M		
	Turn Off Cooling System During Unoccupied Hours in Noncritical Areas	N	N	N		N	N	N	
	Increase Indoor Temperature and Relative Humidity Levels During Occupied Hours	N	N	N	N	N	N	N	
	Do Not Cool Lobbies, Passageways and Storage Areas to the same Degree as Work Areas	N	N	N	N	N	N	N	

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
COOLING									
	Reduce Cooling in Over-Cooled Spaces	N	N	N	N	N	N	N	
	Correct Improper Automatic Control Operation	M	M	M	M	M	M	M	
	Adjust Air Dampers for Tight Closing	N	N	N	N	N	N	N	
	Insulate Chilled Water Piping and Ductwork Located in Unconditioned Spaces	M	M	M	M	M	M		
	Use Outdoor Air for Economizer Cooling	M	M	M	M	M	M	M	M
	Eliminate or Reduce the Use of HVAC Systems which Require Simultaneous Heating and Cooling	M	M			M	M		
	Convert Constant-Volume Fan System to Variable Air Volume	S	S						
	Install Time Clocks on Self-Contained Cooling Units for Automatic Shutoff	M	M	M	M	M	M	M	
	Replace Inefficient Window Air Conditioners	S	S	S	S	S	S	S	
	Reduce Solar Heat Gain	M	M	M	M	M	M	M	
	Reduce Internal Heat Gain	N	N	N	N	N	N	N	
	Use Spot Cooling of People when they are Located Far Apart							S	
	Do Not Permit Perimeter and Interior Systems to Buck One Another	M	M						
	Rebalance Chilled Water and Air Distribution Systems	M	M	M	M	M	M	M	
	Raise Supply Air Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Raise Chilled Water Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Operate Condenser Water System at Lower Temperature	N	N	N	N	N	N		
	Operate Only the Chilled Water Pump and Cooling Tower Fans as Necessary	N	N	N	N	N	N		
	Trim Chilled Water Pump Impeller to Match Load	M	M						
	Use Minimum Number of Chillers. It is far Better to Operate One Unit at 90 Percent Capacity than Two at 45 Percent	N	N						
	Maintain all Cooling Equipment at Peak Efficiency	M	M	M	M	M	M	M	
	Use Proper Water Treatment to Reduce Fouling of Transfer Surfaces in Chillers and Heat Exchangers	M	M	M	M	M	M		
	Use Condenser Water for Air Conditioning Reheat	S	S						
	Check Cooling Tower Bleed-off to Ensure Water and Chemicals are not Wasted	N	N	N	N	N	N		
	Isolate Off-line Chillers	S	S						

TABLE 3-1 CLIMATE ZONE 1 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Junior Halls	Hangars	Maintenance Fac.
MISCELLANEOUS	N = No Cost or Low Cost								
	M = Minimal Cost								
	S = Significant Cost								
	Turn Off Electrical Appliances and Machinery Not Being Used.	N	N	N	N	N	N	N	N
	Turn Off Snow and Ice Melting Equipment, and Heating Tapes when Not Needed	N	N			N	N		
	Improve Maintenance of Motors, Engines & Turbines	N	N	N	N	N	N	N	N
	Make Sure Electrical Power is not Bleeding Off to Ground	N	N	N	N	N	N	N	N
	Examine Elevator Usage; Shut Down Excess Capacity	N	N						
	Install Demand Limiting Equipment	S	S						
	Correct Power Factor	S	S						
	Close Off Unused Areas and Rooms	N	N	N	N	N	N	N	N
	Where Practical, Disconnect Refrigerated Water Fountains	N	N						
	Adjust Valves for Minimal Water Use	N	N	N	N	N	N	N	N
	Use Water Properly for Grounds	N	N	N	N	N	N	N	N
	Meter Cooling Tower Makeup Water	M	M			M	M		
	Wash and Dry Full Laundry Loads Only		N						
	Operate Exhaust Systems Installed Over Washers, Flat Work Ironers, Tumblers, etc. only when needed		N						
	Reschedule Laundry Work Hours to Avoid Peak Electrical and/or Steam Demand		N						
	Turn Off Infra-red Food Warmers when no food is being warmed		N				N		
	Preheat Ovens only for Baked Goods		N				N		
	Check Sterilizer and/or Refrigeration Equipment Doors for Proper Gasketing and Function.								
	Repair and/or Replace as Necessary		N				N		
	Keep Refrigeration Condenser Coils Clean		N				N		
	Check all Refrigeration Systems for Correct Refrigerant Charge to Avoid Excessive Compressor Operation	N	N	N	N	N	N		
	Improve Maintenance of all Electrical/Mechanical Equipment	N	N	N	N	N	N	N	N
	Heat Recovery from Ventilation Air, Lights, Etc.	S	S			S	S		

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
VENTILATION AND INFILTRATION	Shut Down Ventilation Systems During Unoccupied Periods in Noncritical Areas	N	N		N	N	N		N
		N	N	N	N	N	N	N	N
	Reduce Ventilation Rates During Unoccupied Hours to a Minimum in Noncritical Areas	N	N		N	N	N		N
		N	N	N	N	N	N	N	N
	Optimize Ventilation Startup Times	N	N		N	N	N		N
		N	N	N	N	N	N	N	N
	Shut-off Exhaust Systems When Not Needed								
	Eliminate All Unnecessary Exhaust Hoods and Roof Ventilators		M					M	M
		M	M	M	M	M	M	M	M
	Replace Broken Windows								
	Close Fireplace Dampers When Not in Use			N					
	Repair Fireplace Damper if it Does Not Seal Properly			M					
	Adjust Outdoor Air Dampers for Tight Closure	N	N		N	N	N		N
	Reduce Infiltration Through Openings in Building Envelope	M	M	M	M	M	M	M	M
	Establish Rules for all Building Personnel Regarding Opening and Closing of Ext. Doors	N	N		N	N	N	N	N
	Install Weatherstripping Around Windows and Doors	M	M	M	M	M	M	M	M
		M	M	M	M	M	M	M	M
	Caulk Around Window and Door Frames	M	M	M	M	M	M	M	M
		M	M	M	M	M	M	M	M
	Install Economizer Cycle	M	M	M	M	M	M		
	Install Loading Dock Door Seals	M	M	M	M	M	M	M	M
	Rehang Misaligned Exterior Doors	M	M	M	M	M	M	M	M
	Install Automatic Ventilation Controls to Ensure Operation as Needed	M	M		M	M	M		M
	Connect Ventilation Fans in Toilet Rooms to Light Circuit			M	M				
	Reduce the Quantity of Exhaust Air From Hoods		M				M		
	Consider Installation of an Air Curtain					S		S	S
	Recover Heat from Exhaust Air to Precondition Incoming Air	S	S			S	S		
	Recirculate Exhaust Air Using Activated Charcoal Filters	S					S		
	Use Vestibules and/or Revolving Doors to Reduce Infiltration	S	S		S	S	S		
	Replace Hoods that are too Large and Which Move Excessive Quantities of Air		S				S		
	Install Automatic Door Closers on all Exterior Doors	M	M	M	M	M	M	M	M
HEATING	Repair all Leaks: Water, Steam, Air, Fuel, etc.	M	M	M	M	M	M	M	M
		N	N	N	N	N	N	N	N
		M	M	M	M	M	M	M	M
	Lower Indoor Temperature and Relative Humidity	N	N	N	N	N	N	N	N
		M	M	M	M	M	M	M	M
	Add Controls to Setback Temperatures During Unoccupied Periods in Noncritical Areas								
		M	M	M	M	M	M	M	M

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING									
	Install Warm-up Cycle Controls on Air Handling Units With Outside Air Intake as applicable	M	M			M	M		
	Use Opaque or Translucent Insulating Materials to Block Off and Thermally Seal all Unused Windows	S	S					S	S
	Install Storm Windows			S	S		S		
	Add Additional Insulation to Roofs, Ceilings and Floors Over Unconditioned Areas	S	S	S	S	S	S	S	S
	Add Additional Insulation to Walls			S			S	S	S
	Consider Reglazing with Double or Triple Glazing	S	S	S	S		S		
	Evaluate the Necessity for Humidification;								
	Curtail as Practical	N	N						
	Recalibrate All Controls	M	M	M	M	M	M	M	M
	Repair Faulty Equipment: Steam Traps, Valves, Dampers, etc.	M	M	M	M	M	M	M	M
	Lock Thermostats to Prevent Resetting by Unauthorized Personnel	M	M		M		M		
	Reduce Heating in Overheated Spaces. Do Not Open the Window to Cool These Areas!	N	N		N				
	Turn Off or Eliminate all Portable Electric Heaters When Not Needed	N	N	N				N	N
	Keep Doors and Windows Closed When Heating System is Operating	N	N	N	N	N	N	N	N
	Repair Cracks and Openings in Exterior Surfaces	M	M	M	M	M	M	M	M
	Use Infra-red Television Camera System to Determine Where Heat Losses are Occurring from Buildings and Underground Distribution Piping	S	S	S	S	S	S	S	S
	Install and Maintain Insulation on all Hot Water Pipes, Fittings and Valves Passing Through Unconditioned Spaces	M	M	M	M	M			
	Insulate all Steam Lines; Above and Below Ground	S	S		S	S	S	S	S
	Insulate all Duct Work Carrying Conditioned Air Through Unconditioned Spaces	M	M	M	M				
	Repair Insulation on Economizers, Condensate Receiver Tanks, Boilers, Furnaces, etc.	M	M						
	Adjust Dampers in Mixing Boxes and Multi-zone Units so that they Shut-off Tight to Reduce Leakage	N	N						
	Vary the Steam Pressure in Accordance with Space Heating Demands	N	N						
	Reset Heating Water Temperature in Accordance with Load	N	N						
	Operate only Necessary Heating Water Pumps	N	N						

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangers	Maintenance Fac.
HEATING	N = No Cost or Low Cost								
	M = Minimal Cost								
	S = Significant Cost								
	Reduce Hours of Fan and Pump Operation	N	N						
	Operate Return Air Fans for Heating During Unoccupied Hours	N							
	Use Lowest Possible Radiation Temperature in Perimeter Spaces	N							
	Add Controls to Regulate Hot Deck Temperature in Accordance with Demand	M							
	Recover Heat from Condensate	S	S						
	Recover Heat from Condenser Water System	S	S						
	Install Valves and Dampers to Permit Shut-off of Heating in Unoccupied Areas Where There is no Danger of Freezing	M	M						
	Install Automatic Temperature Control Valves in Radiators Controlled by Hand Valves	S	S		S				
	Check Vents in Hot Water and Steam Systems for Proper Performance	N	N		N	N	N	N	N
	Keep Air Movement in and out of Radiators and Convectors Unrestricted	N	N		N	N	N		
	Provide Additional Thermostats for Better Control of Heating Equipment	S	S						
	Convert Three-way Valves to Two-way Operation and Install Variable Speed Pumping	S	S						
	Balance Water Flows to Minimally Satisfactory Levels	S	S						
	Clean Strainer Screens in Pumping Systems	N	N						
	Lower the Resistance to Flow in Duct and Piping Systems	S	S						
	Trim Pump Impeller to Match Load	M	M						
	Reduce Air Flow Rates to Minimally Satisfactory Levels	S	S						
	Adjust all Pumps to Control Leakage at Pump Packing Glands	M	M						
	Maintain all Heating Equipment and Auxiliary at Peak Efficiency	M	M	M	M	M	M	M	M
	Keep Filters and Heat Transfer Surfaces Clean	N	N	N	N	N	N	N	N
	Use Low Resistance Filters, Registers and Grilles to Reduce the Horsepower Required for Air Movement	S	S						
	Reduce Fan Speed	M	M						
	Use the Minimum Number of Boilers. It is far Better to Operate One Unit at 90 Percent Capacity Than Two at 45 Percent	N	N						
	Check Flues and Chimney for Blockages or Improper Draft Conditions	N	N	N					

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac. Warehouses
HEATING	Clean Combustion Surfaces	N	N	N	N	N	N	N	N
	Seal all Air Leaks into Combustion Chamber	N	N	N	N	N	N	N	N
	Adjust Fuel-Air Ratio	N	N	N	N	N	N	N	N
	Maintain Proper Fuel Oil Temperature at Burner Tip	N	N	N	N	N	N	N	N
	Install Flue Gas Analyzer	S	S						
	Preheat Combustion Air With Waste Heat	S	S						
	Install Boiler Stack Economizer for Preheating Feed Water	S	S						
	Add Automatic Draft Damper Control to Reduce Heat Loss Through Breeching When the Gas or Oil Burner is Not in Operation	M	M						
	Use Proper Water Treatment to Reduce Fouling of Heat Transfer Surfaces in Boilers, Heat Exchangers, etc.	M	M						
	Isolate Off-line Boilers	S	S						
	Reduce Blowdown Losses	M	M						
	Replace Existing Boilers Which are not at or near the end of their Useful Life with Modular Boilers	S	S						
	Install Central Supervisory Control System	S	S						
	Utilize Heat from Internal Spaces for Heating Perimeter Areas	S	S						
	Keep Maintenance and Operating Log of all Heating Equipment	M	M						
	Ensure that overhead Unit Heaters Direct Heat to the Floor							N	N
								N	N
LIGHTING	Reduce Illumination to Levels Consistent with Productivity, Safety, and Security Considerations	N	N	N	N	N	N	N	N
	Add Switching and Timers to Turn Off Lights When Not Needed	M	M			M	M	M	M
	Use Daylight for Illumination in Perimeter Areas as Practical	N	N	N	N	N	N	N	N
	Remove unnecessary Lamps when those Remaining Can Provide Desired Illumination	N	N	N	N	N	N	N	N
	Use Higher Efficiency Lamps	S	S	S	S	S	S	S	S
	Remove Lights Over Stacks							M	M
	Establish an Effective Lighting Usage Program	N	N	N	N	N	N	N	N
	Move Desks and Other Work Surfaces to a Position and Orientation that will Use Installed Luminaires to their Greatest Advantage	N	N						

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac. Warehouses
LIGHTING	N = No Cost or Low Cost								
	M = Minimal Cost								
	S = Significant Cost								
	Revise Cleaning Schedule so Lights can be Turned Off Earlier	M	M						
	Add Photocell or Time Controls To Operate Outdoor Lighting	M	M	M	M	M	M	M	M
	Keep Lamps, Luminares, and Interior Surfaces Clean	N	N	N	N	N	N	N	N
	Consider the Use of Light Colors for Walls, Floors and Ceilings to Increase Reflectance but Avoid Specular Reflections	M	M	M	M	M	M		
	Use More Efficient Ballasts	S	S			S	S	S	S
	Relocate Luminares to Provide Light on Task Areas	S	S			S	S	S	S
	Lower Height of Lighting Fixtures	S	S			S	S	S	S
	Recover Heat of Light	S	S			S	S		
COOLING	Repair all Leaks: Chilled Water, Condenser Water, Conditioned Air, etc.	M	M	M	M	M	M		
	Turn off Cooling System During Unoccupied Hours in Noncritical Areas	N	N	N		N	N	N	
	Increase Indoor Temperature and Relative Humidity Levels During Occupied Hours	N	N	N	N	N	N	N	
	Do Not Cool Lobbies, Passageways and Storage Areas to the same Degree as Work Areas	N	N	N	N	N	N	N	
	Reduce Cooling in Over-Cooled Spaces	N	N	N	N	N	N	N	
	Correct Improper Automatic Control Operation	M	M	M	M	M	M	M	
	Adjust Air Dampers for Tight Closing	N	N	N	N	N	N	N	
	Insulate Chilled Water Piping and Ductwork Located in Unconditioned Spaces	M	M	M	M	M			
	Use Outdoor Air for Economizer Cooling	M	M	M	M	M	M	M	M
	Eliminate or Reduce the Use of HVAC Systems which Require Simultaneous Heating and Cooling	M	M			M	M		
	Convert Constant-Volume Fan System to Variable Air Volume	S	S						
	Install Time Clocks on Self-Contained Cooling Units for Automatic Shutoff	M	M	M	M	M	M	M	
	Replace Inefficient Window Air Conditioners	S	S	S	S	S	S	S	
	Reduce Solar Heat Gain	M	M	M	M	M	M	M	
	Reduce Internal Heat Gain	N	N	N	N	N	N	N	
	Use Spot Cooling of People when they are Located Far Apart							S	
	Do Not Permit Perimeter and Interior Systems to Buck One Another	M	M						
	Rebalance Chilled Water and Air Distribution Systems	M	M	M	M	M	M		

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
COOLING									
COOLING	Raise Supply Air Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Raise Chilled Water Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Operate Condenser Water System at Lower Temperature	N	N	N					
	Operate Only the Chilled Water Pump and Cooling Tower Fans as Necessary	N	N						
	Trim Chilled Water Pump Impeller to Match Load	M	M						
	Use Minimum Number of Chillers. It is far Better to Operate One Unit at 90 Percent Capacity than Two at 45 Percent	N	N						
	Maintain all Cooling Equipment at Peak Efficiency	M	M	M	M	M	M	M	
	Use Proper Water Treatment to Reduce Fouling of Transfer Surfaces in Chillers and Heat Exchangers	M	M						
	Use Condenser Water for Air Conditioning Reheat	S	S						
	Check Cooling Tower Bleed-off to Ensure Water and Chemicals are not Wasted	N	N						
	Isolate Off-line Chillers	S	S						
	Repair All Leaks	M	M	M	M	M	M	M	M
	Reduce the Quantity of Water Used	N	N	N	N	N	N	N	N
WATER HEATING	Reduce Generating and Storage Temperature Levels to the Minimum Required	N	N	N	N	N	N	N	N
	De-Energize Booster Heaters in Kitchens at Night			N			N		
	De-Energize Hot Water Circulating Pumps when Building is Unoccupied	N	N						
	Insulate Hot Bare Pipes and Storage Tanks	M	M	M	M	M	M	M	M
	Replace Gas Pilots with Electric Ignition Device			M	M		M		
	Avoid Using Electric Water Heater During Periods of Peak Electrical Demand	N	N	N	N	N	N	N	N
	Insert Orifices in Hot Water Pipes to Reduce Flow	M	M	M	M	M	M	M	M
	Install Efficient Nozzles and Faucets	M	M	M	M	M	M	M	M
	Boost Hot Water Temperature Locally		S				S		
	Recover Heat from Incinerators for Domestic Hot Water Heating		S						
	Recover heat from Laundry and/or Kitchen Waste for Water Heating	S					S		
	Locate Water Heater close to the Point of Use	S	S	S	S	S	S	S	S

TABLE 3-2 CLIMATE ZONE 2 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type								
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.	Warehouses
MISCELLANEOUS	N = No Cost or Low Cost									
	M = Minimal Cost									
	S = Significant Cost									
	Turn Off Electrical Appliances and Machinery Not Being Used.	N	N	N	N	N	N	N	N	N
	Turn Off Snow and Ice Melting Equipment, and Heating Tapes when Not Needed		N							
	Improve Maintenance of Motors, Engines & Turbines	N	N	N	N	N	N	N	N	N
	Make Sure Electrical Power is not Bleeding Off to Ground	N	N	N	N	N	N	N	N	N
	Examine Elevator Usage; Shut Down Excess Capacity	N	N							
	Install Demand Limiting Equipment	S	S							
	Correct Power Factor	S	S							
	Close Off Unused Areas and Rooms	N	N	N	N	N	N	N	N	N
	Where Practical, Disconnect Refrigerated Water Fountains	N	N							
	Adjust Valves for Minimal Water Use	N	N	N	N	N	N	N	N	N
	Use Water Properly for Grounds	N	N	N	N	N	N	N	N	N
	Meter Cooling Tower Makeup Water	M	M							
	Wash and Dry Full Laundry Loads Only		N							
	Operate Exhaust Systems Installed Over Washers, Flat Work Ironers, Tumblers, etc. only when needed		N							
	Reschedule Laundry Work Hours to Avoid Peak Electrical and/or Steam Demand		N							
	Turn Off Infra-red Food Warmers when no food is being warmed		N				N			
	Preheat Ovens only for Baked Goods		N				N			
	Check Sterilizer and/or Refrigeration Equipment Doors for Proper Gasketing and Function.									
	Repair and/or Replace as Necessary		N				N			
	Keep Refrigeration Condenser Coils Clean		N				N			
	Check all Refrigeration Systems for Correct Refrigerant Charge to Avoid Excessive Compressor Operation	N	N	N	N	N	N	N		
	Improve Maintenance of all Electrical/Mechanical Equipment	N	N	N	N	N	N	N	N	N
	Heat Recovery from Ventilation Air, Lights, Etc.	S	S			S	S			

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
VENTILATION AND INFILTRATION	Shut Down Ventilation Systems During Unoccupied Periods in Noncritical Areas	N	N		N	N	N		N
	Reduce Ventilation Rates During Unoccupied Hours to a Minimum in Noncritical Areas	N	N	N	N	N	N	N	N
	Optimize Ventilation Startup Times	N	N		N	N	N		N
	Shut-off Exhaust Systems When Not Needed	N	N	N	N	N	N	N	N
	Eliminate All Unnecessary Exhaust Hoods and Roof Ventilators		M					M	M
	Replace Broken Windows	M	M	M	M	M	M	M	M
	Close Fireplace Dampers When Not in Use			N					
	Repair Fireplace Damper if it Does Not Seal Properly			M					
	Adjust Outdoor Air Dampers for Tight Closure	N	N		N	N	N		N
	Reduce Infiltration Through Openings in Building Envelope	M	M	M	M	M	M	M	M
	Establish Rules for all Building Personnel Regarding Opening and Closing of Ext. Doors	N	N		N	N	N	N	N
	Install Weatherstripping Around Windows and Doors	M	M	M	M	M	M	M	M
	Caulk Around Window and Door Frames	M	M	M	M	M	M	M	M
	Install Economizer Cycle	M	M	M	M	M	M		
	Install Loading Dock Door Seals							M	M
	Rehang Misaligned Exterior Doors	M	M	M	M	M	M	M	M
	Install Automatic Ventilation Controls to Ensure Operation as Needed	M	M		M	M	M		M
	Connect Ventilation Fans in Toilet Rooms to Light Circuit			M	M				
	Reduce the Quantity of Exhaust Air From Hoods		M				M		
	Recover Heat from Exhaust Air to Precondition Incoming Air	S	S						
	Consider Installation of an Air Curtain							S	S
	Recirculate Exhaust Air Using Activated Charcoal Filters	S					S		
	Use Vestibules and/or Revolving Doors to Reduce Infiltration	S	S		S	S	S		
	Replace Hoods that are too Large and Which Move Excessive Quantities of Air		S				S		
	Install Automatic Door Closers on all Exterior Doors	M	M		M	M	M	M	M
COOLING	Repair all Leaks: Chilled Water, Condenser Water, Conditioned Air, etc.	M	M	M	M	M	M		
	Turn off Cooling System During Unoccupied Hours in Noncritical Areas	N	N	N		N	N	N	

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
COOLING	N = No Cost or Low Cost								
	M = Minimal Cost								
	S = Significant Cost								
	Increase Indoor Temperature and Relative Humidity Levels During Occupied Hours	N	N	N	N	N	N	N	
	Do Not Cool Lobbies, Passageways and Storage Areas to the same Degree as Work Areas	N	N	N	N	N	N	N	
	Reduce Cooling in Over-Cooled Spaces	N	N	N	N	N	N	N	
	Correct Improper Automatic Control Operation	M	M	M	M	M	M	M	
	Adjust Air Dampers for Tight Closing	N	N	N	N	N	N	N	
	Insulate Chilled Water Piping and Ductwork Located in Unconditioned Spaces	M	M	M	M	M	M		
	Use Outdoor Air for Economizer Cooling	M	M	M	M	M	M	M	M
	Eliminate or Reduce the Use of HVAC Systems which Require Simultaneous Heating and Cooling	M	M			M	M		
	Convert Constant Volume Fan System to Variable Air Volume	S	S						
	Install Time Clocks on Self-Contained Cooling Units for Automatic Shutoff	M	M	M	M	M	M	M	
	Replace Inefficient Window Air Conditioners	S	S	S	S	S	S	S	
	Reduce Solar Heat Gain	M	M	M	M	M	M	M	
	Reduce Internal Heat Gain	N	N	N	N	N	N	N	
	Use Spot Cooling of People when they are Located Far Apart							S	
	Do Not Permit Perimeter and Interior Systems to Buck One Another	M	M						
	Rebalance Chilled Water and Air Distribution Systems	M	M	M	M	M	M	M	
	Raise Supply Air Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Raise Chilled Water Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Operate Condenser Water System at Lower Temperature	N	N	N					
	Operate Only the Chilled Water Pump and Cooling Tower Fans as Necessary	N	N						
	Trim Chilled Water Pump Impeller to Match Load	M	M						
	Use Minimum Number of Chillers. It is far better to Operate One unit at 90 Percent Capacity than Two at 45 Percent	N	N						
	Maintain all Cooling Equipment at Peak Efficiency	M	M	M	M	M	M	M	
	Use Proper Water Treatment to Reduce Fouling of Transfer Surfaces in Chillers and Heat Exchangers	M	M						

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type								
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.	Warehouses
N = No Cost or Low Cost M = Minimal Cost S = Significant Cost										
COOLING	Use Condenser Water for Air Conditioning Reheat	S	S							
	Check Cooling Tower Bleed-off to Ensure Water and Chemicals are not Wasted	N	N							
	Isolate Off-line Chillers	S	S							
HEATING	Repair all Leaks: Water, Steam, Air, Fuel, etc.	M	M	M	M	M	M	M	M	M
	Lower Indoor Temperature and Relative Humidity	N	N	N	N	N	N	N	N	N
	Add Controls to Setback Temperatures During Unoccupied Periods in Noncritical Areas	M	M	M	M	M	M	M	M	M
	Clean Combustion Surfaces	N	N	N	N	N	N	N	N	N
	Seal all Air Leaks into Combustion Chamber	N	N	N	N	N	N	N	N	N
	Adjust Fuel-Air Rating	N	N	N	N	N	N	N	N	N
	Maintain Proper Fuel Oil Temperature at Burner Tip	N	N	N	N	N	N	N	N	N
	Install Flue Gas Analyzer	S	S							
	Preheat Combustion Air With Waste Heat	S	S							
	Install Boiler Stack Economizer for Preheating Feed Water	S	S							
	Add Automatic Draft Damper Control to Reduce Heat Loss Through Breaching When the Gas or Oil Burner is Not in Operation	M	M							
	Use Proper Water Treatment to Reduce Fouling of Heat Transfer Surfaces in Boilers, Heat Exchangers, etc.	M	M							
	Isolate Off-line Boilers	S	S							
	Reduce Blowdown Losses	M	M							
	Replace Existing Boilers Which are not at or near the end of their Useful Life with Modular Boilers	S	S							
	Install Central Supervisory Control System	S	S							
	Utilize Heat from Internal Spaces for Heating Perimeter Areas	S	S							
	Keep Maintenance and Operating Log of all Heating Equipment	M	M							
	Ensure that overhead Unit Heaters Direct Heat to the Floor							N	N	N
	Install Warm-up Cycle Controls on Air Handling Units with Outside Air Intake as Applicable	M	M			M	M			
	Use Opaque or Translucent Insulating Materials to Block Off and Thermally Seal all Unused Windows	S	S						S	S
	Install Storm Windows			S	S		S			
	Add Additional Insulation to Roofs, Ceilings and Floors Over Unconditioned Areas	S	S	S	S	S	S	S	S	S

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING	N = No Cost or Low Cost								
	M = Minimal Cost								
	S = Significant Cost								
	Add Additional Insulation to Walls	S	S	S	S		S	S	S
	Consider Reglazing with Double or Triple Glazing	S	S	S	S		S		
	Evaluate the Necessity for Humidification;								
	Curtail as Practical	N	N						
	Recalibrate All Controls	M	M	M	M	M	M	M	M
	Repair Faulty Equipment: Steam Traps, Valves,								
	Dampers, etc.	M	M	M	M	M	M	M	M
	Lock Thermostats to Prevent Resetting by								
	Unauthorized Personnel	M	M		M		M		
	Reduce Heating in Overheated Spaces. Do Not								
	Open the Window to Cool These Areas!	N	N		N				
	Turn Off or Eliminate all Portable Electric								
	Heaters When Not Needed	N	N	N				N	N
	Keep Doors and Windows Closed When Heating								
	System is Operating	N	N	N	N	N	N	N	N
	Repair Cracks and Openings in Exterior Surfaces	M	M	M	M	M	M	M	M
	Use Infra-Red Television Camera System to								
	Determine Where Heat Losses are Occurring								
	from Buildings and Underground Distribution								
	Piping	S	S	S	S	S	S	S	S
	Install and Maintain Insulation on all Hot								
	Water Pipes, Fittings and Valves Passing								
	Through Unconditioned Spaces	M	M	M	M	M			
	Insulate all Steam Lines, Above and Below Ground	S	S		S	S	S	S	S
	Insulate all Duct Work Carrying Conditioned								
	Air Through Unconditioned Spaces	M	M	M	M				
	Repair Insulation on Economizers, Condensate								
	Receiver Tanks, Boilers, Furnaces, etc.	M	M						
	Adjust Dampers in Mixing Boxes and Multi-zone								
	Units so that they Shut-off Tight to Reduce								
	Leakage	N	N						
	Vary the Steam Pressure in Accordance with								
	Space Heating Demands	N	N						
	Reset Heating Water Temperature in Accordance								
	with Load	N	N						
	Operate only Necessary Heating Water Pumps	N	N						
	Reduce Hours of Fan and Pump Operation	N	N						
	Operate Return-Air Fans for Heating During								
	Unoccupied Hours	N							
	Use Lowest Possible Radiation Temperature								
	in Perimeter Spaces	N							
	Add Controls to Regulate Hot Deck Temperature								
	in Accordance with Demand	M							
	Recover Heat from Condensate	S	S						

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING	Recover Heat from Condenser Water System	S	S						
	Install Valves and Dampers to Permit Shut-off of Heating in Unoccupied Areas Where There is no Danger of Freezing	M	M						
	Install Automatic Temperature Control Valves in Radiators Controlled by Hand Valves	S	S		S				
	Check Vents in Hot Water and Steam Systems for Proper Performance	N	N		N	N	N	N	N
	Keep Air Movement in and out of Radiators and Convectors Unrestricted	N	N		N	N	N		
	Provide additional Thermostats for Better Control of Heating Equipment	S	S						
	Convert Three-way Valves to Two-way Operation and Install Variable Speed Pumping	S	S						
	Balance Water Flows to Minimally Satisfactory Levels	S	S						
	Clean Strainer Screens in Pumping Systems	N	N						
	Lower the Resistance to Flow in Duct and Piping Systems	S	S						
	Trim Pump Impeller to Match Load	M	M						
	Reduce Air Flow Rates to Minimally Satisfactory Levels	S	S						
	Adjust all Pumps to Control Leakage at Pump Packing Glands	M	M						
	Maintain all Heating Equipment and Auxiliary at Peak Efficiency	M	M	M	M	M	M	M	M
	Keep Filters and Heat Transfer Surfaces Clean	N	N	N	N	N	N	N	N
	Use Low Resistance Filters, Registers and Grilles to Reduce the Horsepower Required for Air Movement	S	S						
	Reduce Fan Speed	M	M						
	Use the Minimum number of Boilers. It is far Better to Operate One Unit at 90 Percent Capacity Than two at 45 Percent	N	N						
	Check Flues and Chimney for Blockages or Improper Draft Conditions	N	N	N					
LIGHTING	Reduce Illumination to Levels Consistent with Productivity, Safety, and Security Considerations	N	N	N	N	N	N	N	N
	Add Switching and Timers to Turn Off Lights When Not Needed	M	M			M	M	M	M
	Use Daylight for Illumination in Perimeter Areas as Practical	N	N	N	N	N	N	N	N

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
LIGHTING	Remove unnecessary Lamps when those remaining Can Provide Desired Illumination	N	N	N	N	N	N	N	N
	Use Higher Efficiency Lamps	S	S	S	S	S	S	S	S
	Remove Lights Over Stacks								
	Establish an Effective Lighting Usage Program	N	N	N	N	N	N	N	N
	Move Desks and Other Work Surfaces to a Position and Orientation that will Use Installed Luminaires to their Greatest Advantage	N	N						
	Revise Cleaning Schedule so Lights can be Turned Off Earlier	M	M						
	Add Photo-cell or Time Controls To Operate Outdoor Lighting	M	M	M	M	M	M	M	M
	Keep Lamps, Luminaires, and Interior Surfaces Clean	N	N	N	N	N	N	N	N
	Consider the Use of Light Colors for Walls, Floors and Ceiling to Increase Reflectance but Avoid Specular Reflections	M	M	M	M	M	M		
	Use More Efficient Ballasts	S	S			S	S	S	S
	Relocate Luminaires to Provide Light on Task Areas	S	S			S	S	S	S
	Lower Height of Lighting Fixtures	S	S			S	S	S	S
	Recover Heat of Light	S	S			S	S		
WATER HEATING	Repair all Leaks	M	M	M	M	M	M	M	M
	Reduce the Quantity of Water Used	N	N	N	N	N	N	N	N
	Reduce Generating and Storage Temperature Levels to the Minimum Required	N	N	N	N	N	N	N	N
	De-Energize Booster Heaters in Kitchens at Night			N			N		
	De-Energize Hot Water Circulating Pumps when Building is Unoccupied	N	N						
	Insulate Hot Bare Pipes and Storage Tanks	M	M	M	M	M	M	M	M
	Replace Gas Pilots with Electric Ignition Device			M	M		M		
	Avoid Using Electric Water Heater During Periods of Peak Electrical Demand	N	N	N	N	N	N	N	N
	Insert Orifices in Hot Water Pipes to Reduce Flow	M	M	M	M	M	M	M	M
	Install Efficient Nozzles and Faucets	M	M	M	M	M	M	M	M
	Boost Hot Water Temperature Locally		S				S		
	Recover Heat from Incinerators for Domestic Hot Water Heating		S						
	Recover Heat from Laundry and/or Kitchen Waste for Water Heating	S	S				S		
	Locate Water heater close to the Point of Use	S	S	S	S	S	S	S	S

TABLE 3-3 CLIMATE ZONE 3 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
MISCELLANEOUS	RETROFIT OPTION								
	Turn Off Electrical Appliances and Machinery Not Being Used.	N	N	N	N	N	N	N	N
	Turn Off Snow and Ice Melting Equipment, and Heating Tapes when Not Needed		N						
	Improve Maintenance of Motors, Engines & Turbines	N	N	N	N	N	N	N	N
	Make Sure Electrical Power is not Bleeding Off to Ground	N	N	N	N	N	N	N	N
	Examine Elevator Usage; Shut Down Excess Capacity	N	N						
	Install Demand Limiting Equipment	S	S						
	Correct Power Factor	S	S						
	Close Off Unused Areas and Rooms	N	N	N	N	N	N	N	N
	Where Practical, Disconnect Refrigerated Water Fountains	N	N						
	Adjust Valves for Minimal Water Use	N	N	N	N	N	N	N	N
	Use Water Properly for Grounds	N	N	N	N	N	N	N	N
	Meter Cooling Tower Makeup Water	M	M						
	Wash and Dry Full Laundry Loads Only		N						
	Operate Exhaust Systems Installed Over Washers, Flat Work Ironers, Tumblers, etc. only when needed		N						
	Reschedule Laundry Work Hours to Avoid Peak Electrical and/or Steam Demand		N						
	Turn Off Infra-red Food Warmers when no food is being warmed		N				N		
	Preheat Ovens only for Baked Goods		N				N		
	Check Sterilizer and/or Refrigeration Equipment Doors for Proper Gasketing and Function. Repair and/or Replace as Necessary		N				N		
	Keep Refrigeration Condenser Coils Clean		N				N		
	Check all Refrigeration Systems for Correct Refrigerant Charge to Avoid Excessive Compressor Operation	N	N	N	N	N	N	N	
	Improve Maintenance of all Electrical/Mechanical Equipment	N	N	N	N	N	N	N	N
	Heat Recovery from Ventilation Air, Lights, Etc.	S	S			S	S		

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTION		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
VENTILATION AND INFILTRATION	Shut Down Ventilation Systems During Unoccupied Periods in Noncritical Areas	N	N		N	N	N		N
	Reduce Ventilation Rates During Unoccupied Hours to a Minimum in Noncritical Areas	N	N	N	N	N	N	N	N
	Optimize Ventilation Startup Times	N	N		N	N	N		N
	Shut-off Exhaust Systems When Not Needed	N	N	N	N	N	N	N	N
	Eliminate All Unnecessary Exhaust Hoods and Roof Ventilators		M					M	M
	Replace Broken Windows	M	M	M	M	M	M	M	M
	Close Fireplace Dampers When Not in Use			N					
	Repair Fireplace Damper if it Does Not Seal Properly			M					
	Adjust Outdoor Air Dampers for Tight Closure	N	N		N	N	N		N
	Reduce Infiltration Through Openings in Building Envelope	M	M	M	M	M	M	M	M
	Establish Rules for all Building Personnel Regarding Opening and Closing of Ext. Doors	N	N		N	N	N	N	N
	Install Weatherstripping Around Windows and Doors	M	M	M	M	M	M	M	M
	Caulk Around Window and Door Frames	M	M	M	M	M	M	M	M
	Install Economizer Cycle	M	M	M	M	M	M		
	Install Loading Dock Door Seals							M	M
	Rehang Misaligned Exterior Doors	M	M	M	M	M	M	M	M
	Install Automatic Ventilation Controls to Ensure Operation as Needed	M	M		M	M	M		M
	Connect Ventilation Fans in Toilet Rooms to Light Circuit			M	M				
	Reduce the Quantity of Exhaust Air from Hoods		M				M		
	Recover Heat from Exhaust Air to Precondition Incoming Air	S	S						
	Recirculate Exhaust Air Using Activated Charcoal Filters	S					S		
	Use Vestibules and/or Revolving Doors to Reduce Infiltration	S	S		S	S	S		
	Replace Hoods that are too Large and Which Move Excessive Quantities of Air		S				S		
	Install Automatic Door Closers on all Exterior Doors	M	M	M	M	M	M	M	M
COOLING	Repair all Leaks: Chilled Water Condenser Water, Conditioned Air, etc.	M	M	M	M	M	M	M	
	Turn off Cooling System During Unoccupied Hours in Noncritical Areas	N	N	N	N	N	N	N	

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
COOLING	Increase Indoor Temperature and Relative Humidity Levels During Occupied Hours	N	N	N	N	N	N	N	
	Do Not Cool Lobbies, Passageways and Storage Areas to the same Degree as Work Areas	N	N	N	N	N	N	N	
	Reduce Cooling in Over-Cooled Spaces	N	N	N	N	N	N	N	
	Correct Improper Automatic Control Operation	M	M	M	M	M	M	M	
	Adjust Air Dampers for Tight Closing	N	N	N	N	N	N	N	
	Insulate Chilled Water Piping and Ductwork Located in Unconditioned Spaces	M	M	M	M	M			
	Use Outdoor Air for Economizer Cooling	M	M	M	M	M	M	M	M
	Eliminate or Reduce the Use of HVAC Systems which Require Simultaneous Heating and Cooling	M	M			M	M		
	Convert Constant-Volume Fan System to Variable Air Volume	S	S						
	Install Time Clocks on Self-Contained Cooling Units for Automatic Shutoff	M	M	M	M	M	M	M	
	Replace Inefficient Window Air Conditioners	S	S	S	S	S	S	S	
	Reduce Solar Heat Gain	M	M	M	M	M	M	M	
	Reduce Internal Heat Gain	N	N	N	N	N	N	N	
	Install Cool-Down Cycle Controls on Air Handling Units With Outside Air Intake as applicable	M	M			M	M		
	Use spot cooling of people when they are located far apart.								M M M
	Do Not Permit Perimeter and Interior Systems to Buck One Another	M	M						
	Rebalance Chilled Water and Air Distribution Systems	M	M	M	M	M	M	M	
	Raise Supply Air Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Raise Chilled Water Temperature in Accordance with Load	N	N	N	N	N	N	N	
	Operate Condenser Water System at Lower Temperature	N	N	N					
	Operate Only the Chilled Water Pump and Cooling Tower Fans as Necessary	N	N						
	Adjust Dampers in Mixing Boxes and Multi-zone Units so that they Shut-off Tight to Reduce Leakage	N	N						
	Lock Thermostats to Prevent Resetting by Unauthorized Personnel	M	M		M		M		
	Maintain all Cooling Equipment at Peak Efficiency	M	M	M	M	M	M	M	
	Use Proper Water Treatment to Reduce Fouling of Transfer Surfaces in Chillers and Heat Exchangers	M	M						

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
COOLING	Clean Strainer Screens in Pumping Systems	N	N						
	Lower the Resistance to Flow in Duct and Piping Systems	S	S						
	Reduce Air Flow Rates to Minimally Satisfactory Levels	S	S						
	Adjust all Pumps to Control Leakage at Pump Packing Glands	M	M						
	Keep Filters and Heat Transfer Surfaces Clean	N	N	N	N	N	N	N	N
	Use Low Resistance Filters, Registers and Grills to Reduce the Horsepower Required for Air Movement	S	S						
	Reduce Fan Speed	M	M						
	Trim Chilled Water Pump Impeller to Match Load	M	M						
	Use Minimum Number of Chillers. It is far Better to Operate One Unit at 90 Percent Capacity than Two at 45 Percent	N	N						
	Install Central Supervisory Control System	S	S						
	Use Condenser Water for Air Conditioning Reheat	S	S						
	Convert Three-way Valves to Two-way Operation and Install Variable Speed Pumping	S	S						
	Check Cooling Tower Bleed-off to Ensure Water and Chemicals are not Wasted	N	N						
	Isolate Off-line Chillers	S	S						
LIGHTING	Reduce Illumination to Levels Consistent with Productivity, Safety, and Security Considerations	N	N	N	N	N	N	N	N
	Add Switching and Timers to Turn Off Lights When Not Needed	M	M			M	M	M	M
	Use Daylight for Illumination in Perimeter Areas as Practical	N	N	N	N	N	N	N	N
	Remove Unnecessary Lamps when those Remaining Can Provide Desired Illumination	N	N	N	N	N	N	N	N
	Use Higher Efficiency Lamps	S	S	S	S	S	S	S	S
	Remove Lights Over Stacks							M	M
	Establish an Effective Lighting Usage Program	N	N	N	N	N	N	N	N
	Move Desks and Other Work Surfaces to a Position and Orientation that will Use Installed Luminaires to their Greatest Advantage	N	N						

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type								
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.	Warehouses
LIGHTING	Revise Cleaning Schedule so Lights can be Turned Off Earlier	M	M							
	Add Photocell or Time Controls To Operate Outdoor Lighting	M	M	M	M	M	M	M	M	M
	Keep Lamps, Luminaires, and Interior Surfaces Clean	N	N	N	N	N	N	N	N	N
	Consider the Use of Light Colors for Walls, Floors and Ceilings to Increase Reflectance but Avoid Specular Reflections	M	M	M	M	M	M			
	Use More Efficient Ballasts	S	S			S	S	S	S	S
	Relocate Luminaires to Provide Light on Task Areas	S	S			S	S	S	S	S
	Lower Height of Lighting Fixtures	S	S			S	S	S	S	S
	Recover Heat of Light	S	S			S	S	S	S	S
HEATING	Repair all Leaks: Water, Steam, Air, Fuel, etc.	M	M	M	M	M	M	M	M	M
	Lower Indoor Temperature and Relative Humidity	N	N	N	N	N	N	N	N	N
	Add Controls to Setback Temperatures During Unoccupied Periods in Noncritical Areas	M	M	M	M	M	M	M	M	M
	Evaluate the Necessity for Humidification; Curtail as Practical	N	N							
	Recalibrate All Controls	M	M	M	M	M	M	M	M	M
	Repair Faulty Equipment: Steam Traps, Valves, Dampers, etc.	M	M	M	M	M	M	M	M	M
	Reduce Heating in Overheated Spaces. Do Not Open the Window to Cool These Areas!	N	N		N					
	Turn Off or Eliminate all Portable Electric Heaters When Not Needed	N	N	N				N	N	N
	Keep Doors and Windows Closed When Heating System is Operating	N	N	N	N	N	N	N	N	N
	Repair Cracks and Openings in Exterior Surfaces	M	M	M	M	M	M	M	M	M
	Use Intra-red Television Camera System to Determine Where Heat Losses are Occurring from Buildings and Underground Distribution Piping	S	S	S	S	S	S	S	S	S
	Install and Maintain Insulation on all Hot Water Pipes, Fittings and Valves Passing Through Unconditioned Spaces	M	M	M	M	M				
	Insulate all Steam Lines, Above and below Ground	S	S		S	S	S	S	S	S
	Insulate all Duct Work Carrying Conditioned Air Through Unconditioned Spaces	M	M	M	M					
	Repair Insulation on Economizers, Condensate Receiver Tanks, Boilers, Furnaces, etc.	M	M							

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type							
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.
HEATING	Vary the Steam Pressure in Accordance with Space Heating Demands	N	N						
	Reset Heating Water Temperature in Accordance with Load	N	N						
	Operate only Necessary Heating Water Pumps	N	N						
	Reduce Hours of Fan and Pump Operation	N	N						
	Operate Return Air Fans for Heating During Unoccupied Hours	N							
	Use Lowest Possible Radiation Temperature in Perimeter Spaces	N							
	Add Controls to Regulate Hot Deck Temperature in Accordance with Demand	M							
	Recover Heat from Condensate	S	S						
	Recover Heat from Condenser Water System	S	S						
	Install Valves and Dampers to Permit Shut-off of Heating in Unoccupied Areas Where There is no Danger of Freezing	M	M						
	Install Automatic Temperature Control Valves in Radiators Controlled by Hand Valves	S	S	S					
	Check Vents in Hot Water and Steam Systems for Proper Performance	N	N	N	N	N	N	N	N
	Keep Air Movement in and out of Radiators and Convectors Unrestricted	N	N	N	N	N			
	Provide Additional Thermostats for Better Control of all Heating Equipment	S	S						
	Balance Water Flows to Minimally Satisfactory Levels	S	S						
	Trim Pump Impeller to Match Load	M	M						
	Maintain all Heating Equipment and Auxiliary at Peak Efficiency	M	M	M	M	M	M	M	M
	Use the Minimum number of Boilers. It is far Better to Operate One Unit at 90 Percent Capacity Than Two at 45 Percent	N	N						
	Check Flues and Chimney for Blockages or Improper Draft Conditions	N	N	N					
	Clean Combustion Surfaces	N	N	N	N	N	N	N	N
	Seal all Air Leaks into Combustion Chamber	N	N	N	N	N	N	N	N
	Adjust Fuel-Air Ratio	N	N	N	N	N	N	N	N
	Maintain Proper Fuel Oil Temperature at Burner Tip	N	N	N	N	N	N	N	N
	Install Flue Gas Analyzer	S	S						
	Preheat Combustion Air With Waste Heat	S	S						

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type								
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.	Warehouses
N = No Cost or Low Cost M = Minimal Cost S = Significant Cost										
HEATING	Utilize Heat from Internal Spaces for Heating Perimeter Areas	S	S							
	Keep Maintenance and Operating Log of all Heating Equipment	M	M							
	Ensure that Overhead Unit Heaters Direct Heat to the Floor							N	N	N
	Install Boiler Stack Economizer for Preheating Feed Water	S	S							
	Add Automatic Draft Damper Control to Reduce Heat Loss Through Breeching When the Gas or Oil Burner is Not in Operation	M	M							
	Use Proper Water Treatment to Reduce Fouling of Heat Transfer Surfaces in Boilers, Heat Exchangers, etc.	M	M							
	Isolate Off-line Boilers	S	S							
	Reduce Blowdown Losses	M	M							
	Replace Existing Boilers Which are not at or near the end of their Useful Life with Modular Boilers	S	S							
	WATER HEATING	Repair All Leaks	M	M	M	M	M	M	M	M
Reduce the Quantity of Water Used		N	N	N	N	N	N	N	N	N
Reduce Generating and Storage Temperature Levels to the Minimum Required		N	N	N	N	N	N	N	N	N
De-Energize Booster Heaters in Kitchens at Night			N				N			
De-Energize Hot Water Circulating Pumps when Building is Unoccupied		N	N							
Insulate Hot Bare Pipes and Storage Tanks		M	M	M	M	M	M	M	M	M
Replace Gas Pilots with Electric Ignition Device			M	M			M			
Avoid Using Electric Water Heater During Periods of Peak Electrical Demand		N	N	N	N	N	N	N	N	N
Insert Orifices in Hot Water Pipes to Reduce Flow		M	M	M	M	M	M	M	M	M
Install Efficient Nozzles and Faucets		M	M	M	M	M	M	M	M	M
Boost Hot Water Temperature Locally			S				S			
Recover Heat from Incinerators for Domestic Hot Water Heating			S							
Recover Heat from Laundry and/or Kitchen Waste for Water Heating			S				S			
Locate Water Heater close to the point of use		S	S	S	S	S	S	S	S	S
Turn Off Electrical Appliances and Machinery Not Being Used.		N	N	N	N	N	N	N	N	N
Turn Off Snow and Ice Melting Equipment, and Heating Tapes when Not Needed			N							

TABLE 3-4 CLIMATE ZONE 4 ENERGY CONSERVATION OPTIONS
(see Figure 3-1 for geographic area of zone)

RETROFIT OPTIONS		Building Type								
		Offices	Hospitals	Family Housing	Dormitories	Commissaries	Dining Halls	Hangars	Maintenance Fac.	Warehouses
MISCELLANEOUS	N = No Cost or Low Cost									
	M = Minimal Cost									
	S = Significant Cost									
	Improve Maintenance of Motors, Engines & Turbines	N	N	N	N	N	N	N	N	N
	Make Sure Electrical Power is not Bleeding Off to Ground	N	N	N	N	N	N	N	N	N
	Examine Elevator Usage; Shut Down Excess Capacity	N	N							
	Install Demand Limiting Equipment	S	S							
	Correct Power Factor	S	S							
	Close Off Unused Areas and Rooms	N	N	N	N	N	N	N	N	N
	Where Practical, Disconnect Refrigerated Water Fountains	N	N							
	Adjust Valves for Minimal Water Use	N	N	N	N	N	N	N	N	N
	Use Water Properly for Grounds	N	N	N	N	N	N	N	N	N
	Meter Cooling Tower Makeup Water	M	M							
	Wash and Dry Full Laundry Loads Only		N							
	Operate Exhaust Systems Installed Over Washers, Flat Work Ironers, Tumblers, etc. only when needed		N							
	Reschedule Laundry Work Hours to Avoid Peak Electrical and/or Steam Demand		N							
	Turn Off Intra-red Food Warmers when no food is being warmed		N				N			
	Preheat Ovens only for Baked Goods		N				N			
	Check Sterilizer and/or Refrigeration Equipment Doors for Proper Gasketing and Function									
	Repair and/or Replace as Necessary		N				N			
	Keep Refrigeration Condenser Coils Clean		N				N			
	Check all Refrigeration Systems for Correct Refrigerant Charge to Avoid Excessive Compressor Operation	N	N	N	N	N	N	N		
	Improve Maintenance of all Electrical/Mechanical Equipment	N	N	N	N	N	N	N	N	N
	Heat Recovery from Ventilation Air, Lights, Etc.	S	S			S	S			

CHAPTER 4

ANALYZING OPTIONS AND DEVELOPING THE PLAN

At the heart of a Base Energy Management Plan is the determination of when various options are to be implemented.

In terms of an overview, consider that there are three primary types of options, defined for the purposes of this discussion as Group I, Group II, and Group III.

- Group I Options are those which can be undertaken with little or no cost. In many cases these options include repair items; for example, replacing broken windows, rehanging misaligned exterior doors, replacing worn insulation, etc. These options also include modifications to the system as designed, some of which can result in significant savings, such as reducing the ventilation rate. Other options relate to improving as-designed elements, for example, by adding weatherstripping or insulation where none previously existed, adding storm windows, etc. These items generally form the bulk of the options carried out in the first year, a significant portion in the second year, and continually less in future years.
- Group II Options are those which generally relate to improving existing systems, but at some expense. Some of those options which have very rapid payback may be implemented in the first year but, for the most part, Group II options may not get underway to any significant degree until the second year.
- Group III Options are those which involve major capital expenditures. These would include, for example, installation of heat reclamation devices, installation of demand control, use of building automation systems, etc. Because of the scope of these systems, and the generally high capital investment required, it generally is worthwhile to investigate the feasibility of each in detail. If staff is available, the feasibility studies should be done in the first year, so the funding to pursue these options can be obtained in a timely manner. Such feasibility studies usually are conducted to provide for second year or third year implementation. However, options having an exceptionally high payback may be considered for earlier implementation.

A suggested five-year plan showing the general relationships of these three categories of options is shown in Figure 4-1. As shown, the first year's activity is taken up primarily by implementing Group I options. A few Group II options are slated for that year, as are some of the Group III options. In most cases, however, the Group III work done in the first year would relate to conducting feasibility studies. As implementation of the plan progresses, more of the modifications come from Groups II and

III. The most important thing to note, however, is that--for the hypothetical case illustrated by Figure 4-1--attention is given to all three types of options throughout the course of the plan.

Determining specifically which particular options to undertake in a given period of time requires analysis of each option in terms of economic and timing factors, as discussed below. Once all the suggested economic and timing analyses have been performed, it then will be possible to identify quickly which options deserve topmost priority, which second priority, etc.

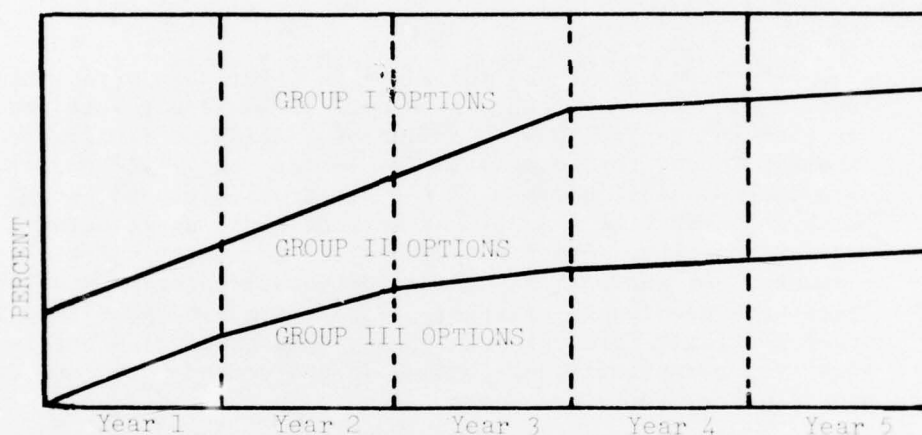


Figure 4-1. Five Year Plan

4.1 Economic Factors Analysis

An engineering and economic analysis of the survey report will indicate how many dollars a given modification will save. Obviously, those which will save the most deserve close scrutiny. Savings, of course, is a relative term, in that one first must consider the amount of money which must be invested to achieve the savings. For the most part, the overriding concept in economic evaluation is life-cycle cost analysis. This concept requires that all benefits and costs incurred throughout the economic life of energy-related improvements be compared on a consistent, time-equivalent basis. The objective of this kind of analysis is to determine not only which modifications are worth doing, but the extent to which they are worth doing. Life cycle costing is fully discussed in AFCEC-TR-77-12.

4.2 Timing Factors Analysis

Several different types of timing factors must be considered. Each option must be evaluated in terms of each factor to establish the earliest date at which it could be implemented. This does not mean that an option which could be implemented tomorrow should be implemented tomorrow. It may not be a practical pursuit for another two years.

Manpower and funding requirements create significant timing factors. Implementing the energy management plan will require a commitment of manpower and expertise similar to that required for development. The program must be timed to have a minimal impact on the day to day operation of the base as well as ongoing funding programs. Careful programming is essential to achieve optimization of both limited manpower and funding resources.

Modifications that require large capital expenditures may require preliminary study. The time and cost required for these studies must also be integrated into existing programs.

Some modifications may cause a negative impact. These negative impacts occur for the most part during implementation and can be minimized by appropriate timing. For instance, it probably would be best to modify the heating system in summer and the cooling system in winter, assuming that such modifications will cause a substantial amount of downtime for the system.

Various modifications to achieve the same end result also require proper timing. It would be wasteful to modify a boiler at significant expense when, due to age, it would have to be replaced in a year or two.

4.3 Developing the Plan

Once options have been analyzed, those which are most appropriate for follow-up in the first year will immediately become obvious. Due to restraints of manpower and budget, of course, not all options which could be undertaken within the first year will be able to be undertaken. Thus, through a process of "selective weeding," those options appropriate for the first year will be identified.

The plan itself must contain more than just the possible technical changes. It should also include indications of techniques which will be employed to communicate developments and gain the commitment and cooperation of all base and tenant personnel, as discussed in Chapter 5.

In presenting the plan for review and approval, a summary sheet, such as shown in Figure 4-2 may be useful.

Building	Option	Initial Costs (\$)	Annual Savings (Btu)	Annual Savings (\$)	Payback Period (Years)	Energy Source
#42	Preheat Combustion Air	21,000	$7,178 \times 10^6$	13,800	1.52	Oil
	Replace Worn Boiler Controls	8,750	$4,785 \times 10^6$	9,235	0.95	Oil
	Reduce Air Volume	23,000	$1,587 \times 10^6$	16,250	1.42	Electricity
	Install Automatic Thermostats	800	90×10^6	170	4.70	Oil
	Provide Lighting for Specific Tasks	8,000	254×10^6	3,200	2.50	Electricity
#11	Use more Efficient Fluorescent Lamps	54,000	$1,536 \times 10^6$	15,760	3.42	Electricity
	Reduce Air Volume	17,000	$1,024 \times 10^6$	10,500	1.62	Electricity
	Install Switching	32,000	614×10^6	6,300	5.08	Electricity

Figure 4-2. Summary of retrofit options.

CHAPTER 5

IMPLEMENTING THE BASE ENERGY MANAGEMENT PLAN

Implementing the plan involves four separate concerns: implementing the energy management options; gaining the cooperation and support of all base and tenant personnel; monitoring the program to keep it effective; and continuing education. Because implementing the energy management options have been addressed, discussion here relates to the latter three concerns. AFM 91-12, Chapter 3, provides guidance for gaining cooperation and support of all base personnel.

5.1 Gaining Cooperation and Support

Gaining the cooperation and support of all base and tenant personnel comes about in two ways: by example and by communication.

The "example" method already has been mentioned, and relates directly to the commitment from above. The "communication" element bears further discussion, primarily in the form of techniques which can be used to gain the support required. In most cases, Base Public Relations Personnel can be of substantial assistance.

5.1.1 Policy Letter

As soon as the plan is established, the Base Commander should issue a policy letter indicating his own support and commitment to the energy management program, and request all other personnel to cooperate and lend assistance. The policy letter also could include information on the nature of the program and the reasons for its establishment (such as those included in Chapter 1), as well as the goal of the program, names of the Energy Management Team, etc.

5.1.2 Directives and SOP's

The Energy Management Team, with the approval of the Base Utilities Management and Conservation Committee, should issue directives and Standard Operating Procedures (SOP's) which detail to various units new procedures they should follow in order to reduce energy consumption. The SOP's should be developed jointly between the Energy Management Team and those who will have to carry them out.

5.1.3 Meetings

Formal meetings can be held to explain the program in general and provide more specific information for the audience in particular. For example, a meeting could be held to explain how energy consumption can be reduced in base residences, in dormitories, etc. Lists of suggested actions could be handed out at that time. If possible, indicate how much energy something like a lightbulb left burning needlessly for three hours

wastes, and how much that waste costs. Recognize, too, that there will be informal meetings, such as in dining halls. Those involved in implementing the Energy Management Plan should "talk up" the program, emphasizing the need for conservation and how simply conservation can be achieved.

5.1.4 News Releases

News releases usable for the base and community news media--including radio--should be issued on a regular basis. Releases can cover subjects such as announcement of program establishment, members of the Energy Management Team, etc., as well as--on a monthly basis--how much energy has been saved as compared with a year earlier. News releases also form a means to recognize those who make contributions of time, effort, or ideas which are truly significant. It may be desirable to prepare special news release stationery for the sole use of the Energy Management Team.

5.1.5 Public Service Advertisement

Public service advertisements can be prepared for both base and community news media. These ads can stress energy conservation in general, or can focus on just one way to save; for example, by turning out lights when they're not needed--"KILL-A-WATT." Print advertisements can be prepared much as any other type display ad. Radio ads can be based on a script to be read by the station announcer or by special tapes prepared by the Public Relations Officer. TV spots can comprise slides, filmstrips, film, or videotape, with soundtracks or scripts. In any event, because the advertisements are intended for the public good, the media should not charge for space or time. (Consult with media news directors, publishers, advertising managers, etc.).

5.1.6 Point-of-Use Signs

Point-of-use signs refers to small signs such as those placed over light switches which remind users of energy efficiency action. For example, a sign near an exterior door may read, "SAVE ENERGY. PLEASE BE SURE DOOR IS CLOSED SECURELY."

5.1.7 Base Consumption Signs in Buildings

An effective technique aimed at obtaining the cooperation of personnel within a given building is to provide a large chart which indicates base energy consumption during the year and goals. Each month the new consumption figures could be posted indicating whether or not goals for the month were met. Building Custodians can play a key role in these tasks as well as assisting with point-of-use signs and posters.

5.1.8 Posters

Posters with the same type message as those used for public service ads can be placed throughout the base.

5.1.9 Contests

Numerous types of contests can be conducted to heighten interest in the program. These include developing effective slogans, such as "KILL-A-WATT" or "BT-YOU," development of logos for the program, and so on. These contests could be held among children of base personnel, etc.

5.1.10 Suggestions

Use of the suggestion program should be encouraged so people can send in their ideas on how to conserve energy. Good suggestions should be rewarded appropriately and reported through news releases.

5.1.11 Energy Hot Line

An Energy Hot Line (telephone) directly to the Energy Management Team may be useful. This would allow free communication by all personnel to identify energy conservation opportunities. A program of this nature does require timely feedback for all inputs.

5.1.12 Other

Ideas for promoting the Base Energy Management Program are limited only by the human imagination. In general, however, maximum cooperation can be achieved when a note of humor is used from time to time and with good taste.

5.2 Program Monitoring and Updating

Program monitoring takes several forms. The most obvious form, of course, is through use of energy consumption data to determine how well the program is coming along in the aggregate. These data will indicate, too, how effective a given modification has been, and where additional effort is required.

Two other types of monitoring also are required. One type is that needed to ensure that a given modification has been made according to plans and specifications. The other involves spot-checking of personnel to determine to what degree they are cooperating, where problems are occurring, and so on.

Approximately six months into the first year of implementation of the Base Energy Management Program, the overall results of monitoring should be utilized with an eye toward underlining what changes, if any, are required for the balance of the year. At the same time, based on the results of monitoring, the plan for the second year should be established, much in the manner that the first year's plan was created.

The second-year plan should be reviewed approximately 9 months into the first year to determine what changes--if any-- should be made.

5.3 Continuing Education

In order for the gains made through a Base Energy Management Program to be sustained, continuing education is required. There are numerous seminars being conducted, for example, from which engineering staff of the Civil Engineering Group can derive great benefit. In some cases it even may be appropriate to retain firms to develop seminars specifically for base personnel. Also, consider developing a special library or section of a library specifically for the many new periodicals and other publications which deal with energy management and conservation.

It should be noted that a special package of materials should be developed for those who arrive on base after the program is initiated. Many of the materials suggested above, such as directives, can be used for this purpose. New employees in all areas will require special indoctrination to insure not only that they will cooperate with the goals of the Base Energy Management Program, but also that they understand specifically how they should perform a given task to ensure that high energy efficiency is maintained.

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